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THE PHYSIOLOGY OF FEATHER PATTERN

BY FRANK R. LILLIE

WHITMAN LABORATORY OF EXPERIMENTAL ZOOLOGY

I. INTRODUCTION.

II. PLUMAGE AREAS.

III. THE PATTERN OF THE INDIVIDUAL FEATHER.

1. Experimental modifications.
   a. By injections of thyroxin.
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I. INTRODUCTION

In coöperation with colleagues, whose work will be discussed in the following pages, I have been engaged during the last ten years in studying the manifestations and control of sexual characteristics in the Brown Leghorn fowl chiefly. The characters of the highly dimorphic plumage have engaged our attention from the start, and the readiness of control of plumage sex-characteristics led us to make a special study of the mechanisms concerned. This resulted in the discovery that differences of rate of growth of different feather tracts are highly determinative for the threshold of reaction to the female sex hormone (Juhn and Gustavson, 1930; Juhn, Faulkner, and Gustavson, 1931). The idea then occurred to me that differences in the rates of growth of parts of the individual feather might similarly be an important factor in the determination of its pattern, whether sexual or not; and an extended analysis of development and growth of feathers confirmed this

theory (Lillie and Juhn, 1932). It has been suggested to me that the principles involved should be of general interest to ornithologists.

It should be stated at the start that the range of physiological determination (by hormones, other physiological conditions of the organism, and environment) is limited by genetic determiners, which include, in my opinion, not only the general genetic make-up of the organism, but also the skin mosaic factors responsible for the formation of different feather types in different tracts, as for instance in the saddle and breast of male Leghorns or capons. Nevertheless, the range of physiological determination of feather structure and pattern is very considerable. The analysis of experimentally determined variations may be expected to throw some light also upon the principles determining natural feather pattern.

In the experiments the female sex hormone and crystalline thyroxin were used. Injections of these produce specific effects on feathers, showing wide quantitative ranges dependent on concentration. Males or capons of the Brown Leghorn fowl were used exclusively for the experiments. The female sex hormone was prepared by our coöperating biochemist, Dr. R. G. Gustavson, from placenta or human pregnancy urine. It should be recalled in this connection that male hormone is without noticeable effect on the plumage of this breed of fowl, and that the plumage of the capon or poularde is the same as the male in all major aspects. The effect of the female hormone is to induce the female form, structure and pattern, specific for each feather tract, in all regenerating feathers, so long as its concentration is above the threshold of reaction. Thyroxin, "in physiological doses", produces definite pattern effects, more especially in the "lacy" feathers of the saddle, back, and neck.

These hormones are administered by subcutaneous injections. There is, therefore, always a period of absorption during which the concentration of the substance is rising in the blood to a maximum, dependent on the dose, and a period of excretion during which the concentration of the substance in the blood is sinking. An "intensity curve" can be used to picture these conditions (see Fig. 52). If the maximum is above the "threshold of reaction", a definite effect is produced, the quantity of which is dependent on the duration of threshold-concentration. The effect begins to manifest itself after a variable latent period, if concentration in the blood is above the minimum for reaction (threshold); and increases as concentration rises to the maximum, then decreasing again to disappearance. The result of

this is to establish a symmetrical mark in the vane of the feather. Accurately measured amounts of hormone were always used.

It is obvious that by suitably repeated injections the level of concentration of hormone in the blood may be kept constant, or caused to fluctuate up or down as desired. A great variety of patterns may thus be produced.

For the interpretation of the results knowledge of the *mechanics* of development of the feather is necessary. As this was substantially unknown, a detailed study of the development of the feather was necessary (Lillie and Juhn, 1932).

In all of the studies summarized here regenerating feathers of males or capons were used. Feathers regenerate promptly at any season of the year at constant rates. In order to obtain any desired stage for study of hormone effects, definite feathers are plucked at known periods of time before beginning any experiment, and preserved for comparison with the experimental regenerating feathers. The results can thus be compared with the predecessor feather, from the same follicle if desired. The record is completed after regeneration by preserving the experimental feathers also.

We may divide our review into two parts, the first dealing with plumage areas, the second with the individual feathers.

II. Plumage Areas

We shall discuss this subject briefly, and only with reference to areal gynandromorphism; but it deserves attention because the principle of relationship between rate of growth and threshold of reaction was first discovered here. Domm (1927) observed that in the reversion from male type plumage, which follows sinistral ovariotomy, to female type, which develops more or less completely at a later time, feathers of the back and saddle may be first affected; however, no special attention was given to this phenomenon. Juhn and Gustavson (1930) found in their experiments of injection of female hormone into capons, that, when a series of daily injections was interrupted for a day, the regenerating breast feathers recorded the interruption by temporary reversion to male type, while the regenerating saddle feathers remained pure female in type. They interpreted this to mean that excretion of the female hormone during the interruption had reduced the concentration in the blood below the threshold of reaction for the breast feathers, but not below the threshold for the saddle feathers; in other words, that the breast feathers had a higher threshold of reaction than the saddle feathers. They found also that it was possible to induce

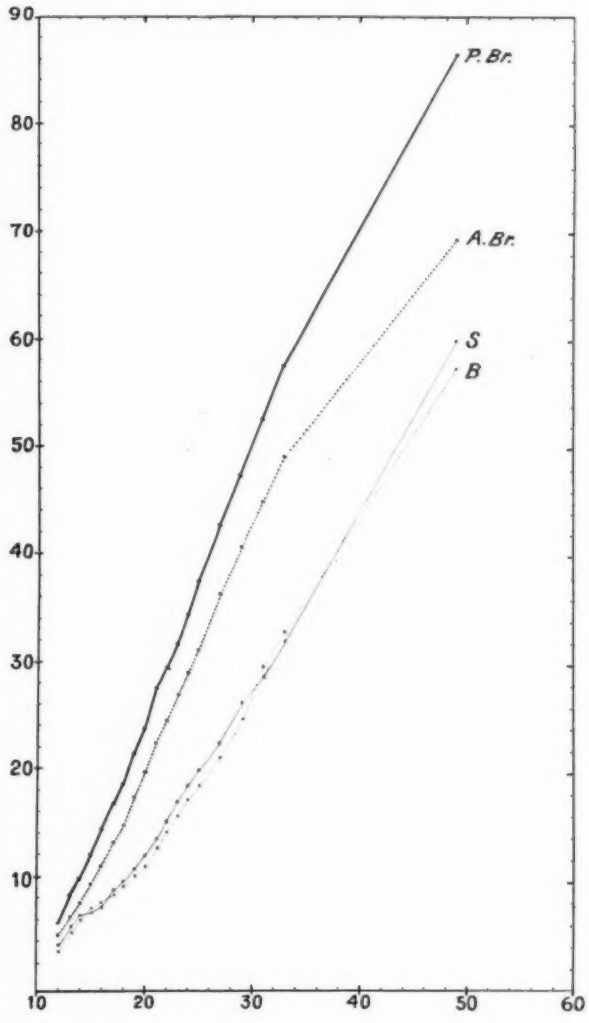


Fig. 38. Rate of growth of feathers in length in the male Brown Leghorn. The four curves represent the average daily increase in length of twenty feathers in each of four regions from the twelfth to the forty-ninth days of regeneration. P. Br. is for postrior breast region; A. Br., anterior breast; S., saddle; B., back; abscissae, in days; ordinates, in millimeters. From Juhn, Faulkner and Gustavson, 1931.

hen-feathering in the saddle with a low concentration of female hormone in the blood, that did not affect the breast feathers at all; and thus confirmed the conclusion. They also noted that breast feathers grow at a much more rapid rate than saddle feathers and suggested a causal relationship between rate of growth and threshold of reaction.

Juhn, Faulkner, and Gustavson (1931) then made an extended study of this subject. They studied average daily rates of growth in the posterior part of the breast, the anterior part of the breast, in the back, and in the saddle. The results are shown in the accompanying graph (Fig. 38). By a long series of experiments they then determined that there is a direct relationship between the growth rates of the male feathers and the concentration of female hormone in the blood required to change the type of the regenerating feather from male to female. The relationship is, in fact, roughly proportional to the linear growth rates recorded, concentrations of about the proportions of 3:4:6 being required for female modification in the saddle, anterior breast, and posterior breast, respectively. These differences are sufficient, in view of the "all-or-none" character of the reactions, to bring about areal gynandromorphism of plumage. They also found an antero-posterior gradient of growth in the plumage of the breast, and medio-dorsal transverse gradients in other feather tracts, as well as in the breast, that were reflected in the results of various experiments.

These results were applied by the writer to the explanation of bilateral gynandromorphism, which has been described in ten distinct cases reported in the literature (Lillie, 1931). He found in four of the cases that a decided hypertrophy of the side bearing the male plumage had been figured or described by the authors; in two of the cases this happened to be the right side and in two it was the left side. In the other cases the conditions of symmetry of the bird's body had not been considered. In all cases, in which the internal anatomy was described, there was evidence of ovarian deficiency, and thus presumably of an abnormally low supply of female hormone. In the more numerous cases of lateral hemihypertrophy known in human subjects there is often, at least, an excessive growth rate of epidermal structures on the hypertrophied side. If we assume that this is the case also for feathers, the principle of relationship between growth rate and threshold of reaction would necessarily determine, in cases of ovarian deficiency of a certain degree, that the more rapidly growing side would produce male feathers and the more slowly growing side female feathers. It is at least certain that the condition can be

explained in principle on the basis of the relationships experimentally determined between growth rates and hormone threshold.

III. The Pattern of the Individual Feather

Although feather patterns are almost infinitely diversified, there are undoubtedly certain fundamental physiological principles that underlie all. The physiological analysis to be presented is based upon experiments with one breed of fowl; nevertheless the fundamental factors are present here as they would be in any other case; and it would probably be possible to reach a common agreement as to what they are. Assuming this, it will be seen that the analysis is probably significant for the interpretation of feather pattern in general. In each case there are certain genetic and mosaic factors pertaining to species, race, and feather tract that are special; for the purpose of physiological analysis these are taken for granted.

Like the entire organism the feather is a bilateral structure with a more or less pronounced tendency to asymmetry both in form and pattern. All of its variations and modifications are to be referred to its axis (the rhachis), to its apical and basal ends, to its free margin, and to its outer and inner surfaces. The modifications to be considered are restricted to the vane proper. The structural elements concerned are the rhachis, the barbs and barbules, and the pigment.

We shall deal first with experimental modifications of pattern; and afterwards with the development of the feather as a means of interpretation.

1. Experimental modifications.

a. By injections of thyroxin.

The feathers in which the effects of thyroxin are most clearly marked belong to the saddle, back, and neck-hackle tracts of the male or capon. These feathers agree in being long, acuminate, and lacy, i. e., with barbules confined to the basal region of the barbs, to an extent which increases regularly from near the apex to the base of the vane (Fig. 39).

In preparation for the experiment feathers are plucked previously, so that regenerating feathers of known age are present. Accurately measured subcutaneous injections of Squibb's crystalline thyroxin are then administered. Figrues 42-46 record the effects of single injections of increasing amounts of thyroxin in saddle feathers of five different birds; the figures are photographs of regenerating feathers plucked several weeks after the injection. The weakest injection (0.5 mg.) is recorded as a narrow spindle-shaped pigmented area

centered on the rhachis; the next (1 mg.) produces a similar but broader mark with its widest point above the center; in the succeeding cases (1.5, 5.0, and 10 mg.) the mark becomes progressively wider until it reaches the margin. The form of the mark records the absorption and excretion of the thyroxin; its modifications through the series are due, so far as width is concerned, to increasing lateral extension with increase in dose, and, so far as its form is concerned, to more rapid absorption than excretion with rising doses. The mark is caused by the extension of barbule formation farther from the rhachis than normal, and by the formation of large active melanophores wherever barbules appear. It will be noticed also that the feather becomes shorter and broader as a whole with increasing dosage, though even the highest dosage employed is not sufficient to induce premature molting, as excessive doses will do.

The important thing to notice, however, is that there is a decreasing susceptibility to thyroxin in each barb from its base to apex. In other words, the threshold of reaction to thyroxin forms an ascending gradient along each barb. The study of the development of the feather shows conclusively that all levels of forming barbs are present simultaneously at each stage of regeneration, so that the failure of more apical levels to show thyroxin effects with the lower doses can be due to nothing else but a difference in susceptibility.

Interesting patterns can be produced by injections of thyroxin at suitably spaced intervals. Two examples are shown in Figures 40 and 41 in the case of neck hackle feathers. Fig. 39 is a normal control; the pattern in Fig. 40 was produced by injection of 1 mg. thyroxin every seventh day during regeneration, and in Fig. 41 by injection of 1.5 mg. every sixth day. Variations of amount and interval produce yet other variations on the theme.

b. By injections of female hormone.

The female hormone, prepared from sources previously mentioned, affects all kinds of feathers that are sexually dimorphic, causing an abrupt change from male to female type during the period that it is effective. Its action thus differs from the action of thyroxin not only in the number of kinds of feathers affected, but also radically in type of reaction. The changes produced by thyroxin are never of a sexual nature; those produced by the female hormone are always of this nature. However, as only a few factors are concerned (general form of the feather, presence or absence of barbules, presence or absence of chromatophores, and the color and arrangement of the pigment produced) superficial resemblances between the effects of thyroxin and of female hormone do appear, especially in the lacy feathers.

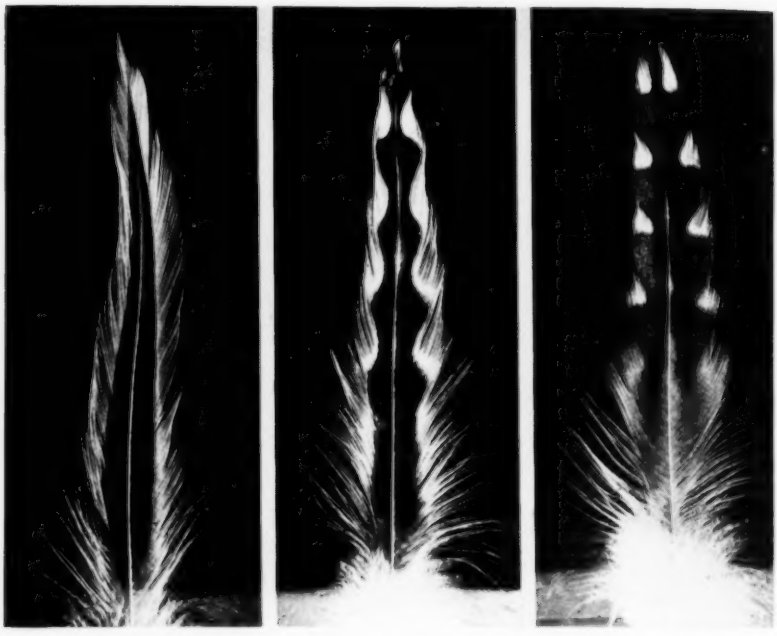
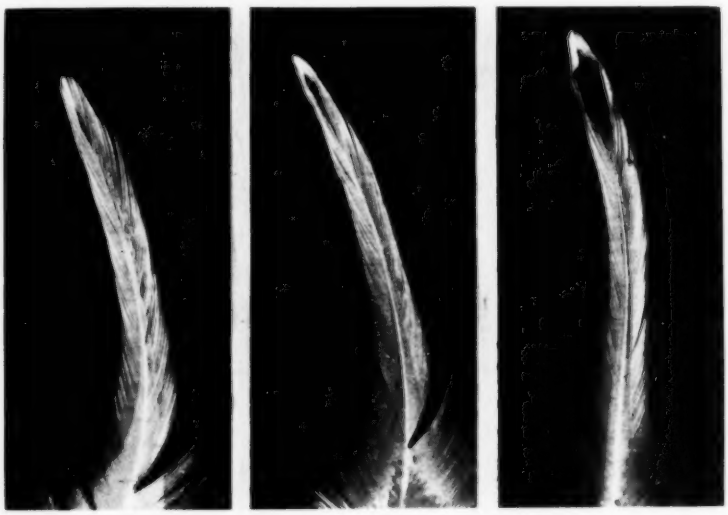


Fig. 39. (Left). Neck hackle feather of male Brown Leghorn; normal control. From Lillie and Juhn, 1932.

Fig. 40. (Center). A neck hackle feather from a male Brown Leghorn that had received 1 mg. of thyroxin by subcutaneous injection every seventh day during the growth of this feather. From Lillie and Juhn, 1932.

Fig. 41. (Right). Same type of feather as in Fig. 40 from a bird receiving 1.5 mg. of thyroxin every sixth day during the growth of this feather. From Lillie and Juhn, 1932.



Figs. 42-43-44. Tips of saddle feathers from Brown Leghorn males recording increasing single doses of thyroxin. Fig. 42 (left), 0.5 mg. Fig. 43 (center), 1 mg. Fig. 44 (left), 1.5 mg. (See also Figs. 45 and 46). From Lillie and Juhn, 1932.

Figs. 45-46. Tips of saddle feathers from Brown Leghorn males recording increasing single doses of thyroxin (continuation of figures 42-44). Fig. 45 (left), 5 mg. Fig. 46 (right), 10 mg. From Lillie and Juhn, 1932.

Figs. 47-48. Left group. The formation of female bars on a male background by injection of female hormone on three successive days during growth (500 rat units injected each day). Fig. 47 (left) from right anterior breast. Fig. 48 from left anterior breast. From Lillie and Juhn, 1932.

Figs. 49-50. Right group. The formation of male bars on a female background by omitting every seventh day of an otherwise daily injection of female hormone during the entire growth of the vane (60 rat units daily for twenty-seven days). From Juhn and Gustavson, 1930.

In the case of the feathers of the saddle, back, and neck, the patterns produced by single or repeated doses of female hormone bring out the same principle of a gradient of thresholds along the axis of each barb in a manner similar to thyroxin (see figures in Juhn, Faulkner, and Gustavson, 1931). There is no need, therefore, to give any details of these experiments.

The special properties of the breast feathers bring out certain consequences more clearly. Only one change is concerned, viz., in the color, from the black of the male to the salmon-colored, or orange, of the female. Breast feathers in general have the highest threshold for female hormone of all contour feathers; and in the breast itself the posterior feathers have a higher threshold than the anterior feathers. The bases of the barbs in any given feather have a relatively low threshold, and the threshold of reaction rises towards the apex. Increasing concentrations of hormone record marks extending from the rhachis towards the margin of the vane.

However, another factor enters into the realization of the female marking produced. This is the *principle of reaction rate*. The margin of the vane (apical sections of barbs) has a much more rapid reaction rate than the axial part. This operates in two ways: first by reducing the period of time (latent period) after attainment of threshold-concentration in the blood before onset of reaction, and second by increasing quantity of reaction occurring in a given time. Thus, female reaction may occur within 24 hours after a sufficient dose, in the margin, whereas from 48 to 72 hours are required in intermediate and axial portions of the vane with any dosage above threshold requirements. The consequence of difference of latent period is that a single dose may record a mark at the margin of the vane alone if it is heavy enough, and if it can be excreted before 48 to 72 hours after injection, a time which covers the latent periods of the remainder of the vane.

The principal of reaction rate is of equal importance with the principle of gradient of threshold in determining the form of a physiologically induced pattern.

By virtue of the two principles of threshold and rate of reaction, transverse bars of female color may be produced in breast feathers by suitable injections of female hormone for two or three days, because the margin of the feather, although having a more rapid rate, records the effect for a shorter period of time owing to its higher threshold than the axial part. Differences in rate and threshold may thus balance one another, producing equal effects all the way across the vane (Figures 47 and 48).

Female bars may thus be produced on a male background by injections for short periods of time; or male bars may be produced on a female background by running a continuous series of injections during the entire growth of the feather, except for stated interruptions, during which the hormone is excreted to below the threshold of the female reaction (Figures 49 and 50).

The patterns that we have hitherto considered are transverse to the axis of the feather in their general arrangement. But it is obvious, according to the same principles, that if one side of the vane of any feathers should have a higher threshold than the other, a correspondingly intermediate dosage of female hormone would affect only the side with the lower threshold, and thus a longitudinally gynandromorph feather would be formed such as have been described by Pézard, Sand, and Caridroit (1926), by Bond (1913), and which has been realized in our own experiments (Lillie and Juhn (1932).

2. Gradients of growth-rate in the development of the feather.

If the same principle of relationship between levels of threshold and rate of growth that we found to obtain between feather tracts should also apply to the individual feather, then we could transpose our experimentally determined gradients of threshold into gradients of growth rate. This was the consideration that induced us to study anew the development of the individual feather (Lillie and Juhn, 1932). For all the details I must refer to the original paper; the conclusions alone can be stated here.

The feather forms form a complete ring of cells established as a thickening of the epidermal layer of the feather papilla at its base, immediately bounding the umbilicus. The original embryonic form of the feather is thus a ring. The rhachis arises by concrescence of the two ring halves, accompanied by continuous growth of the ring, or *collar* as we shall call it; the point of concrescence establishes the dorsal side of the ring, the point opposite being the mid-ventral line. The rhachis is thus composed of two lateral halves fused together. It continues to grow in length so long as the collar maintains its activity. The halves of the collar are continually flowing from the mid-ventral line in opposite directions into the rhachis, the energy for the motion being furnished by very active cell-division and growth. The development of the rhachis is thus from apex to base, as has long been known.

The barbs arise as outgrowths of this ring parallel to one another, perpendicular to the ring, and closely applied to the surface of the pulp. Each arises next to the mid-ventral line, and its attachment to

Fig. 51. Split preparation of a feather germ twelve days after beginning regeneration from the breast of a Brown Leghorn capon. The wall of the conical feather germ was split along the ventral side and spread out flat on a microscope slide after removing the pulp. The rhachis is in the center of the photograph. The youngest barbs are at the margins. The unpigmented base is the collar, bounded by the umbilicus below. From Lillie and Juhn, 1932.

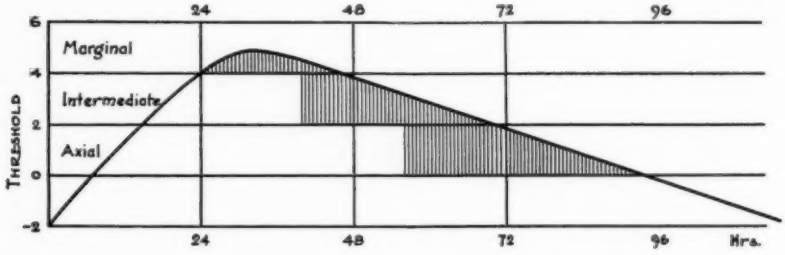


Fig. 52. Half vane; intermittent hormone action. *Curve of intensity.* Effect of female hormone on the breast feather of the Brown Leghorn capon according to a particular dosage. Such a curve of intensity will result in the formation of an even bar from center to margin of the vane (*cf.* Figs. 47-48). Other dosages will produce yet other curves of intensity, resulting in different patterns. The ruled areas indicate duration of reaction—in the present case deposition of pigment of the female type—in the parts of the vane concerned. The ordinates represent the thresholds of reaction of the parts of the vane from axis to margin, and the abscissae represent time in hours. See discussion in text, page 208.

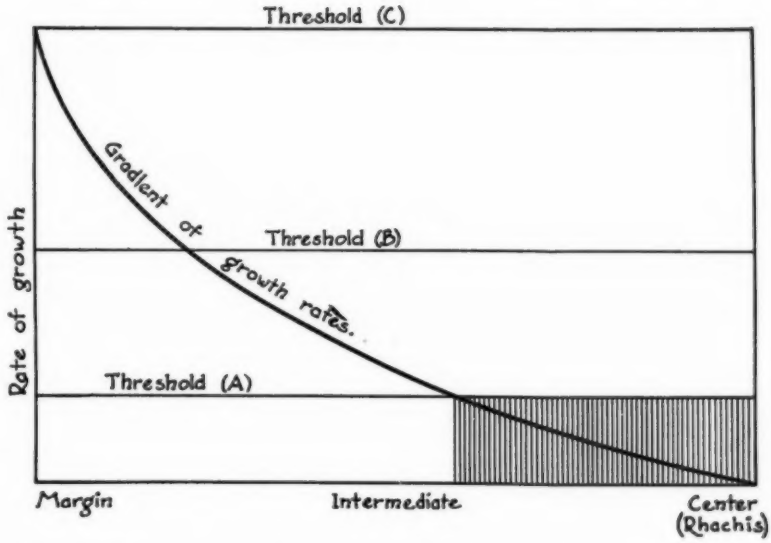


Fig. 53. Half vane; constant hormone action. The hormone action is supposed to maintain a constant level of intensity corresponding to Threshold *A* or Threshold *B*, or Threshold *C*. The reaction is represented for Threshold *A* only, by the ruled area. Rate of growth is plotted as ordinates against position in the vane from margin to center. The intersection of threshold, which is directly proportional to rate of growth, with the curve of gradient of growth rates gives the position in the vane to which the reaction extends from the center (=rhachis).

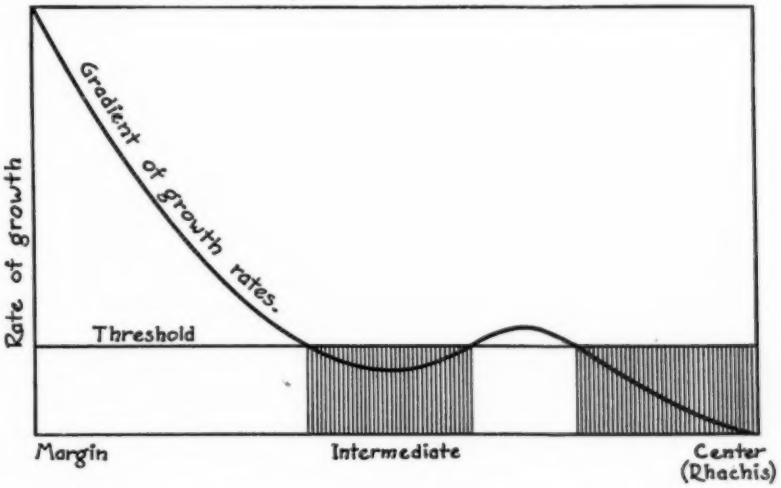


Fig. 54. Half vane; constant hormone action. The curve of growth rates represented here is entirely theoretical, and is postulated to explain longitudinal stripes of intermediate position in the vane. See text, page 210. "Center"=rhachis.

the collar is fixed. As it grows in length it is carried along one side or the other of the two halves of the collar by the flowing movements concerned in the formation of the rhachis until it reaches the point of concrescence on one or the other side of the definitive rhachis, when its growth is fully completed. The time required for transfer from mid-ventral to mid-dorsal line and completion of growth is about ten days in the case of barbs from the middle of the vane of the breast feather. The apical region of the barb is formed first and adjacent regions, to base, in succession; the growth is apico-basal.

There are thus two time-gradients in the feather; from apex to base along the rhachis, and from margin to center along the barbs.

The characters of each barb are finally determined for all the elements that enter into its composition within a very narrow zone adjacent to the collar, *the zone of determination*. It is within this zone that all hormone effects are registered: above it development cannot be altered; below it the cells are still purely embryonic. It will be seen, on reflection (*cf.* Fig. 51), that the zone of determination, from the dorsal to the ventral surface of the feather germ, intersects all barb levels. Thus in any given experiment all levels of barbs are accessible to the hormone.

The growth-rate of the rhachis is approximately uniform, during the formation of the vane at least. This is clearly indicated by the curves in Fig. 38. The slight decrement shown after about thirty days for the feathers of the breast indicates the transition from the vane to the fluffy part of the feather. Certain slight pattern changes along the axis of saddle feathers have suggested, however, that there may be a slight decrement of growth-rate from apex to base not detected by the somewhat rough measurements. The outstanding fact, however, is the approximate uniformity of growth-rate along the axis of the feather.

The rate of growth of the barbs, on the other hand, decreases very greatly from apex to base along a well-defined gradient of growth (*cf.* Fig. 53). The determination of this principle was based upon the possibility of establishing a base line just above the collar throughout its entire extent by suitable hormone injections (Lillie and Juhn, 1932), which make a colored band. In the course of the subsequent growth this base line is moved unequally upward along the axis of feather germ. The inequality of movement registers the unequal rates of growth of successive levels of the barbs, which can be represented in a curve of rate of growth, as in Fig. 53.

The form of the curve has been estimated as accurately as possible from the data at our disposal for the breast feather. It is not, however, to be regarded as mathematically exact. The indication conveyed by the curve that the lateral half of the vane may be divided roughly into three longitudinal zones—an axial zone with slowest growth rate, an intermediate with slightly higher growth rate, and a marginal with greatly increased growth-rate—is of significance. In the case of the saddle feather of the capon there are indications that the form of the curve differs in some details, though the great difference in rate between the margin and the remainder of the vane obtains here also. The indications are that curves of growth-rate of the barbs differ typically between rounded and acuminate contour feathers.

The experiments definitely prove that there is a close agreement between threshold of reaction and growth-rate along the axis of barbs. The various patterns formed by injections of hormones are fully explained as to their form by the gradients of growth-rate. The finer composition of the patterns, however, depends upon other inherited capacities and potencies of the particular feather concerned.

IV. General Discussion

It is reasonable to suppose that the principle of a gradient of growth rates along the axes of the barbs during the development is a general one. It goes far towards explaining the more general features of feather pattern, if we are further allowed to assume that genes operate in the developing feather in manners similar to hormones. A single determining factor, such as a hormone or gene, may produce great variety of results (patterns) depending on curve of intensity and periodic activity.

No pattern is exactly symmetrical; for feathers, like other structures exhibiting bilateral symmetry, always possess an underlying asymmetry, more or less pronounced. There exists every grade of departure from bilateral symmetry in the feathers of fowl down to quite extreme asymmetry. The grade of asymmetry bears certain definite relations to the main axes of the entire body, or the wings, as will be more precisely defined in a paper to be published later. Symmetrical patterns therefore grade into asymmetrical patterns by imperceptible degrees.

It should also be noted that, as the two sides of the vane develop independently of one another, any pattern of the entire vane depends for its symmetry on simultaneous and equal processes in the two halves of the collar. Any disturbance of the processes that affects the two

sides unequally will result in a certain amount of asymmetry. Thus it is probably very seldom that the two halves of a transverse bar fit one another exactly on the rhachis. That such fitting is, however, usually so close is a revelation of precision in the developmental process.

As a symmetrical pattern is thus composed of two equal halves, it is sufficient to consider one side of the vane.

For descriptive purposes patterns may be divided into transverse, longitudinal, and concentric.

1. Transverse patterns.

These are due to *intermittent factors* operating during the development of the feather.

The most complete form of the transverse pattern is the bar. We have already seen how, with intermittent action of hormone, the factors of threshold and rate of reaction may be so equalized as to produce a bar of even width across the vane. This depends, as we have already seen, on a rise and fall of hormone concentration of such a kind that its highest point is above the threshold requirements of all transverse levels, and its beginning and end below all thresholds.

The matter can be presented in diagrammatic form as follows (Fig. 52): The ordinates represent threshold of reaction, and the abscissae time in hours. The rise and fall of hormone action is plotted as a curve derived from the general results of numerous experiments and according to dosage of female hormone described in a previous paper (Lillie and Juhn, 1932). This curve intersects all threshold levels twice—in its ascending and in its descending limb. Reaction begins in the margin, owing to its rapid rate, at about 24 hours; it ceases at about 46 hours, owing to excretion of hormone shown in the descending curve. Reaction does not begin in the intermediate portion of the vane until about 40 hours, owing to its slower rate of growth; it lasts until about 70 hours, when the curve falls below its threshold. In the axial portion of the vane reaction does not begin until about 56 hours owing to a yet slower rate, and it lasts until 90 hours, or more, when the curve falls below its threshold also. Thus, an even bar of reaction is recorded all across the vane, because the decreasing time of action from axis to margin is compensated by increment of growth-rate. The threshold levels are, of course, not sharply divided in three as the exigencies of the diagram demand, but flow into one another as indicated in the curve (Fig. 53).

If the curve of hormone action does not rise to the threshold of the marginal portion of the vane, axial patterns form, of a width dependent on the height of the hormone curve, as in the case of thyroxin patterns, in the saddle and neck feathers (Figs. 40-46). The form varies with the relations between the ascending (absorption) and descending (excretion) limbs of the curve. If the descending limb of a curve exceeding the threshold level of the margin should be very steep, and fall below the axial threshold without intersecting the reaction period of the axial portion of the vane a marginal mark would be made stopping short of the axis. In the case of hormone action this means very rapid excretion. Theoretically, the descending limb might intersect the reaction zone of both marginal and axial portions, missing the intermediate reaction zone entirely. This has been realized in our experiments (Lillie and Juhn, 1932). Theoretically, also, the descending limb might intersect only the beginnings of the marginal, intermediate, and axial zones, leaving three spots in a transverse line across each side of the vane. In all of these cases the patterns are modifications of the bar.

A special form of transverse pattern is confined to the tip of the feather, as in so-called spangled breeds of fowl. Dr. Juhn and the writer have pointed out that the developmental history of the tip of the feather differs slightly from the remainder and have suggested that this may be a basis for tip patterns (Lillie and Juhn, 1932, pp. 135-136, 138-139).

We have dealt with hormones as intermittent factors determining transverse patterns by their operation upon the form of development characteristic of the feather germ. Their operation is restricted by the processes of absorption and excretion, and the time factors involved. In the barred breeds of fowl we have a genetic determining factor. One of my students, Dr. G. Montalenti of the University of Rome, has studied this pattern and found that its development follows the same course as that of bars determined by hormones. The only difference is the greater precision and more rapid control. It is obvious from his study that the gene in question exhibits rhythmic activity according to a curve of intensity, with ascending and descending limbs, and that the even width of the bar is due to a gradient of threshold of reaction combined with reaction rates precisely similar to those determined by us for the Brown Leghorn. This paper will be published shortly.

Inherited patterns of the individual feather may thus depend on the same principles of growth and development as physiologically induced patterns.

2. Longitudinal patterns, unlike transverse patterns, which are due to factors operating intermittently, are dependent on factors acting constantly throughout the development of the feather. If a physiological factor, such as a hormone, be of constant low intensity, it will record a longitudinal stripe next to the rhachis (Fig. 53, Threshold *A*); if it be of slightly greater intensity, but still below the threshold of the margin, it will record a wider stripe leaving an unmodified margin (Fig. 53, Threshold *B*); if its intensity throughout be above the threshold of the margin also, the entire vane will be affected (Fig. 53, Threshold *C*).

Constant factors can thus record a positive (axial) and a negative (marginal) stripe side by side, but cannot record two or more positive stripes, so long as the gradient of growth-rates is a descending curve from margin to rhachis. If, however, the gradient should descend for a short distance, then ascend again, before making its final descent to the margin, a constantly acting factor of proper intensity would record two positive stripes separated by a negative stripe and followed by a marginal negative stripe (Fig. 54). Such a gradient of growth rates is purely imaginary, though it is conceivable that it may be found to exist in feathers of certain patterns. Its interest is in helping to show the range of control of pattern theoretically possible on the principle of relationship between rate of growth and threshold of reaction. In this connection it may further be noticed that with such a gradient of growth rate and a factor acting intermittently, such as the barring factor, at a certain grade of intensity, spots would be produced, arranged in both transverse and longitudinal rows, as in the guinea fowl.

3. Concentric patterns may also be derived theoretically from the principles already laid down. In the case of the thyroxin mark, for instance, the pattern is not simple, but is composed of three effects: the first to appear in point of time is a more or less pronounced blanching of pigment freshly deposited; shortly after, the formation of barbules is stimulated; then the deposition of melanin pigment occurs. Thus, there are three serial effects. When the mark fails to reach the margin, the three zones thus created are concentric. They

occur, as a matter of fact, in Figures 43 to 45; but, as they are not sharply contrasted, it requires careful examination of the actual specimen to see them (*cf.* Lillie and Juhn, 1932). The concentric pattern thus depends for its origin on differences of threshold of the elements composing the mark under conditions of a suitable intensity curve.

The principles that we have stated reveal only a small part of the mechanism that nature uses in the production of certain qualities that we have termed pattern in the constitution of the individual feather; they enable us to understand certain abnormalities such as gynandromorphism whether in the individual feather or in the entire plumage; they may be useful in experimental modification or control of some plumage characteristics; they also have broader biological applications. The experiments show, I think, that the plumage of birds is a wonderful material for experimental analysis, and I hope they may enlist the interest of ornithologists to extend them to other forms. Certainly we have here a very little explored and, in all probability, a very fertile field for experimental research.

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STUDIES ON THE BEHAVIOR OF THE GREAT HORNED OWL

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This paper is written on the basis of observations and experiments made during three years (1929-1932) of wild life study in south-central Wisconsin, in which the Great Horned Owl, *Bubo virginianus*, was given rather special attention. It should be admitted, however, that data on behavior were acquired incidentally, the primary purpose of the work being food habits research.

Let us begin with the nestling owlet. My own data have to do with twenty-nine Wisconsin horned owl nests, twelve of which were visited regularly. Of juveniles from the latter, ten were kept tethered to prolong the food habits studies (see Errington, Paul L., Technique of raptor food habits study. The *Condor*, Vol. XXXIV, March-April, 1932, pp. 75-86) some months past the time when they would have flown. In addition, work was done with six captive juveniles, including four birds hand raised from more or less early stages.

The first two weeks in the young horned owl's life have a singularly profound effect upon its future disposition. Recently hatched owlets accustomed to no source of food other than their human attendants came to recognize them somewhat as they would their own parents, even displaying what appeared a great deal like true affection. On the other hand, an owlet reared by its parents through approximately one-fourth of its growth never did really tame, though it tolerated discreet handling. Two juveniles captured shortly before they could fly remained untamable; the nearest they ever came to a compromise with the enemy was to approach for food when forced by hunger—and then only with the most obvious of misgivings.

Hand reared juveniles fed only dead prey were at the age of several months still very helpless, to all appearances quite devoid of active killing instinct. Upon the release of live English Sparrows into the cage of one such owl, it regarded the sparrows with evident curiosity and eventually made a series of clumsy, futile hops in their direction. Handed a live sparrow, the owl reached out and took it, held it gently in its talons while looking it over, and finally let it slip away, uninjured. The raptor then came to me and started tugging at my finger for something to eat. Ultimately this bird learned to kill and eat sparrows left in the cage overnight, but not until many months old and in full adult plumage could it be taught to kill larger prey. Parallel experiences were had with another Horned Owl and with a Barred Owl similarly raised.

The owlet taken when about a quarter grown was best for experimental purposes. It was neither so tame as to be a spoiled pet nor so wild as to react unnaturally in captivity. It would permit of no familiarities but was not hostile. It was merely "its own owl", and matters progressed smoothly as long as the inviolability of its person was respected.

Sparrows were admitted into the cage of this bird when it had attained adult size; it made catches from the beginning, improving steadily in skill with practice. Live Norway rats were then tried, which the bird killed with ease. A medium-sized Belgian hare was not attacked (May 18, 1930) nor was a guinea pig (June 1). The guinea pig, moreover, by frantic efforts to escape and possibly by its alien strangeness, frightened the owl into flying up and clinging to the wire of the cage top. For days the demoralized raptor would not attack even the rats which it had previously handled with facility. Five days of fasting (June 21 to 26) were required to force this bird into killing its own food again, rats being turned into the cage at intervals during this time. On July 7, it was fed, banded, and freed in a suitable woodlot about a mile south of Madison. It was shot four miles east of the city by a hunter, December 20.

One of the wild grown juveniles struck and killed a fifth-grown cottontail rabbit on its first attempt (May 25, 1930). The owl started at once to tear off pieces from the victim's head and to swallow them. Thus, without past experience, this wild creature did what was to be done, if a trifle crudely, which may be contrasted with the ineptness of pets that couldn't do so well several months later. Rats were taken care of with equal effectiveness and more precision, but the darting guinea pig likewise drove this bird up on the wire (June 1). As in the other case, the guinea pig incident ruined the confidence of this owl as a killer. Thereafter (up to June 17), it too was afraid of the rats which should have given it no alarm. Especially was this true of rats that advanced; rats that retreated stood an infinitely better chance of finding an owl on top of them.

The hand-reared horned owls did not become really wild as long as they were dependent upon man for food—at least for twenty months, which is the longest that I have information on a single individual. They became cross and excitable as they matured, nevertheless, and resented more and more any liberties taken with them. The two tamest of my experimental birds at the age of four months would be likely to draw blood if picked up carelessly, largely I think as an unintentional consequence of increased strength. Subjected to what

they seemingly felt indignities, they pinched and grasped with beak and talons in a rough but not vicious manner; that is, their defense inflicted pain but not injury. The two did not change much after four months save to become more irritable and to lose a little—incredibly little—of their helplessness.

The experimental work gave rise to sundry opinions as to what would happen if the tame owls ever got away. Partial enlightenment was forthcoming in a couple of instances. A juvenile about three months old escaped to fly from tree to tree and to alight on a lawn more than a quarter mile away. There it sat, apparently bewildered. Upon noticing my approach, it came to meet me on foot. The other instance concerned two owls (aged six and nineteen months) kept in a small building which was broken open one night by human marauders. Morning came, and the oldest bird was waiting inside, despite the open door. The youngest was gone. On the third day the young man who was caring for the captives heard the familiar call of a hungry juvenile Horned Owl in a woods near by. As he came within fifty yards or so of the woods, an owl sailed out, flew directly toward him, and lit at his feet to be picked up.

Although horned owls as a rule seemed to show an underlying uniformity of behavior, the temperaments of some birds were noted to differ considerably.

To illustrate: Of the ten tethered juveniles, eight characteristically sought escape by flight at each visit during the gathering of food habits data. One employed a definite sequence of hiding, flight, and offense tactics; first, it would conceal itself by "freezing" at the base of the tree to which tethered; then, it would endeavor to take wing; and, last, it would attack. The tenth rarely sought to hide or fly but would await visitors in plain sight, scowling sourly, and requiring only that human legs be within range of the tether chain before it would arrive in all sincerity, eight talons and beak.

This latter youngster was the only one of the tethered ten that ever learned to adapt itself to my semi-weekly visits. It learned to leave me alone if I left it alone, but at the least hint of overt intent on my part, it would be at me, the embodiment of utter ferocity. This juvenile, the most savage with which I have had dealings, happened to be of the same brood as the most helpless and innocuous pet owl I have known.

Nesting studies brought out temperament differences in adult owls, also. Altogether, I have had sufficient intimate relations with adults from twenty nests to speak positively. Parents from eleven would

keep at a distance, sometimes being visible through the trees 150 to 200 yards off, but usually in a position to see, if unseen themselves. At any rate, this is the impression I gained from hearing faint though eloquent hooting deeper in the woods. Nine sets of parents would "talk" and snap their bills from trees within fifty yards of the nest, these birds being in sight most of the time. Three nests were dangerous to visit alone, on account of the old birds attacking. I have twice been badly lacerated by adults defending their young, to say nothing of the occasions I have saved my skin by dodging or by waving off assaults. The presence of a second person completely discouraged actual attacks.

In general the parents displayed the most solicitude toward their young about the time that the latter were ready to leave the nest. This was the culmination of attachments which appeared quite loose prior to the hatching of the eggs. The old birds, too, would fly off and leave downy owlets just out of the egg without apparent reluctance. As the owlets grew, the parents tended to remain more in the immediate environs in the event of disturbances. Usually one of the birds stayed much closer—presumably the female—though sometimes both would perch in the same tree or even on the same limb. Their nearness was directly proportional to the nearness of the investigator to the young; when he was up in the nest, the old ones not infrequently came to the next tree; as he descended they made off into the woods; if he ascended again, they returned.

As parental attachment reaches its height, the adults will often go to any lengths within their physical powers in behalf of their young, even to the extent of flapping on the ground as if crippled. This I have witnessed three times, twice (on consecutive years and in the same woodlot) by what I believe to be the same owl. A more ridiculous sight than a perfectly functional horned owl simulating a broken wing is difficult to imagine. In all three instances in which I observed the broken wing trick to be employed, the crazed parents had first tried everything else in their repertoire; the rarity of this sort of performance—in my experience, at least—is possibly indicative of instincts now hardly more than residual from early avian phylogeny.

Parental obligations to nestlings seem fulfilled for the most part by protection against interlopers and by making available a certain amount of food. The feeding relations of old to young appear on the whole to be indiscriminate. The owlet that gets fed is the one that wants the food and takes it. If the last owlet to hatch from a

clutch of eggs is able to feed regardless of the competition of its stronger nest-mates, it lives; otherwise it is neglected and dies.

Attempting to gain further insight into horned owl family life, I once placed in a nest containing two large juveniles a tame youngster of corresponding age (April 24, 1930). The old birds apparently accepted the stranger without much ado, for the latter was seen to be completely at home the next visit (April 26). May 4, all three juveniles, now ready to fly, were sitting together, looking over the edge of the nest.

The intensity of parental devotion toward the tethered owls was on the wane by June, and this doubtless applies to the free juveniles, now capable flyers. Adults attending two tethered juveniles successfully kept late into the season of 1931 were slackening in their duties still more by the middle of July, but continued to bring food until release of the young, August 8. There was no doubt, nevertheless, that the food was being brought in diminishing quantities coincident with the "weaning" of the free juveniles, the hungry calling of which could be heard throughout almost any occupied woodlot.

The obvious deduction is that the species will look after its young just about so long in accordance with inherent reproductive mechanics. The length of the feeding period of young by adults does not, then, seem correlated with the variable individual needs of the young as affected by circumstances. The "weaning" of mid-summer culminates the protracted juvenile education, whether, it may be presumed, the young have learned to hunt or not.

One of the best observations I have been able to make on "weaning" had to do not with horned owls but with screech owls. In this case (July 5, 1932; Ruthven, Iowa), three young and an adult were watched for a time between sunset and dark. The family was feeding on some sort of insects, the identity of which could not be made out in the dusk. The young swooped frequently, with more or less success. When followed to successive perches by a mendicant youngster, the old bird took flight again.

From scattered, fragmentary bits of data a reasonable inference can be drawn that the adult owls by indifference and maybe by punishment gradually compel their troublesome progeny to shift for themselves. I am convinced that no normal juvenile horned owl fails to take advantage of family support as long as such is to be had. When deprived, it does what it has to.

Where does the juvenile go, after it takes up a wholly independent existence? Of thirteen horned owl nestlings (birds that had never been tamed, tethered, or experimented with in any way to reduce their prospects for survival) personally banded in 1930 and 1931, three were reported shot within a year or so, all at points thirteen to twenty miles of where banded. Similarly scanty data from banded nestling barred owls bear out the belief that the young of resident large owl species, generally, take up quarters a considerable distance from their natal woodlots. This wandering furnishes an explanation for the numbers of horned owls caught seasonally by pole traps on some game farms and hunting club properties.

Conversely, there is good though not indubitable evidence that the Wisconsin adults studied tended to stay from year to year in the same territory. Unfortunately, I have nothing as definite as banding data on adults upon which to base conclusions. I have merely observed in a few instances distinctive behavior on the part of owls seen in woodlots on consecutive years and also continued partiality for certain nest sites not intrinsically of exceptional attractiveness.

For late summer and early autumn, data on horned owl behavior have been virtually unobtainable until the falling of leaves lessened the cover value of deciduous woods. The owls' choice of daylight hiding places restricted to a comparatively limited number of trees still retaining leaves or those draped with vines or otherwise adequate, their retreats may then be better located. It proved extremely difficult —virtually impossible—to make direct observations on the owls themselves, except by flushing the birds, to confirm the fact that certain places were being used; the main reliance was placed on reading of fresh signs about the roost.

Prior to 1932, it was noted casually that horned owls were apt to station themselves in the fall in the near neighborhood of old stick nests (hawk or crow) which they would appropriate in the spring. During the season of 1931-1932 this was checked up more carefully. In the late fall, 1931, five horned owl territories were discovered in regular use (judged by birds seen and by accumulations of feces and pellets beneath roost trees), of which four proved to be nesting areas. Three other nesting areas, not actually visited in the fall, betrayed by old pellets their early occupancy. Exception: one pair did not move into their nesting territory until January or later, though breeding was not delayed, as incubation had started by February 21, 1932.

None of the twenty-nine 1930-1932 Wisconsin horned owl nests upon which personal data were procured showed evidence of having been built or remodeled to any degree by the strigine occupants. In practically every case the owls' nest-making instincts seemed satisfied by cleaning out the debris from the immediate bottom of the nesting place and by lining the same with variable quantities of breast feathers. Nest sites chosen were: red-tailed hawk nests, thirteen; crow nests, eight; hollow trees, three; unidentified stick nests, two; holes or crevices in rock faces, two; fox-squirrel nest, one. Nests taken over were usually in secluded locations, the prospective occupants requiring mainly privacy and convenience; in other respects the birds displayed very limited judgment in selecting nests, as four were of such flimsy construction that they disintegrated during the storms or from use, to dump eggs or owlets on the ground.

It is true that the precipitation of an owlet from a crumbling nest is not necessarily an event of dire consequence to the species. If the owlet is of fair size, it can lessen the violence of its fall by spreading its part-grown flight feathers; if it is not this far fledged, it may still be sufficiently tough to withstand a comparatively terrific impact. Even young horned owls are put together to stay.

Once on the ground, if the owlet is too small to move with facility, it will stay about where it fell and will come to regard that spot as its proper nest, though it may be situated in the middle of a snow bank. Owlets from two nests, reared on the ground from early in their development, assumed the usual defense attitude upon the approach of a man but up to a certain size or age limit made no attempt to leave, as did those of corresponding advancement finding themselves in unfamiliar surroundings. Fallen owlets large enough to get along well on the ground promptly moved off in almost any direction. These wanderers were usually to be located hiding at the base of trees twenty to two hundred yards from the original nests. Moving or remaining stationary, the owlets are cared for by the old birds; since the adults are both faithful providers and formidable protectors, it may make scant difference in the end whether the young spend their full time in the nest or not.

At any rate, there is little question of the horned owl within its geographic range being a successful species under ordinary wilderness and backwoods conditions and in some settled communities. Essen-

tially a bird of low intelligence, it is equipped with a set of stereotyped behavior patterns, effective nevertheless in enabling it to take care of itself generally, except when confronted by novel emergncies or those racially recent. While the horned owl does learn, it learns with difficulty proportional to the remoteness of the new experience from its regular life routine. It exhibits, too, a ponderous adaptiveness by which it sometimes lives in environments as diverse as the buckbrush patches of treeless plains and the suburbs of cities.

In the face of man's persecution its survival is perhaps attributable as much to its secretiveness as to any single factor aside from accidentally favoring circumstances. To the pole-trap it has no answer, nor to the shooting of its young from its nests, nor to the destruction of its environment. It has but the one refuge—sometimes adequate, sometimes not—from the complex perils arising through man and man's enmity. It simply keeps out of sight.

A study of the food habits of the horned owl re-emphasizes the same mechanistic undercurrent conspicuous elsewhere in the species life history. Its food habits as a species are governed by where it is, by what it has access to (see Errington, Paul L., Food habits of southern Wisconsin raptors, Part I—Owls. The *Condor*, Vol. XXXIV, July-August, 1932, pp. 176-186). One can expect practically any animal within its habitat and of a size within its power to handle to be represented in the diet of the Great Horned Owl; exempt only are species the habits and adaptations of which do not leave them vulnerable. Commonly taken are the more nocturnal animals such as rabbits, flying squirrels, rats, mice, skunks, weasels, shrews, small owls, large insects; and more occasionally diurnal forms handicapped by darkness, i. e., poultry, grouse, flickers, meadowlarks, many small birds, fox-squirrels, chipmunks, etc.

From the examination of some 1900 pellets I feel justified in saying that choice plays a minimum role in the horned owls' routine hunting. The horned owl presumably goes out with the intention of getting something to eat, to take what it encounters first and is able to get. The victim is usually a rabbit, for the apparent reason that rabbits are conspicuous, more or less abundant, and easily obtainable. They are large and satisfying and may serve for several meals. Conceivably, the individual owl may recognize somewhat the superiority of the rabbit as prey and be influenced in its hunting thereby, but

other forms likewise highly available will not be overlooked. The horned owl is not particular when it wants to eat. Even carrion is not unacceptable. I knew a horned owl to feed on a skinned cow carcass when the surrounding woods held plenty of cottontails (March, 1931).

When the captive horned owls had eaten they were satisfied, though extraordinary availability of prey would tempt them to kill more than they needed at the time. Living prey by its movements in proximity to feeding owls diverted the latters' attention from killed food already in possession and so invited attack, which did or did not materialize. The reaction, as observed in experiments with horned owls and English Sparrows, seemed wholly reflexive, in no way suggesting any particular enjoyment of killing on the part of the predators used.

In the wild, killing in excess of immediate needs is indicated by the occurrence now and then of two heads of medium-sized individuals of prey in the same pellet. This does not appear to happen often, however, except during the nesting season when the adults must bring in more food than they themselves require, either for the owlets directly or in anticipation of the hatching of the eggs. The evidence from fall and winter pellets shows that horned owls are prone to eat all or nearly all of a given kill. For example, bones of some prey species so exceptional that they could reasonably belong only to the identical individual may be present in two or more pellets from a certain owl.

Broadly, the horned owl is a simple creature of simple needs. It has physical and psychic qualities of positive, neutral, or negative survival value. Its nocturnal habits and silent approach give it a distinct advantage over many types of prey; these, combined with the might of its talons compensate greatly for its inflexibility of behavior. Where the direct and indirect pressure of man is heavy against the species, its natural endowments may not suffice. But whether it thrives or declines, the species will doubtless continue to respond to the vicissitudes of its existence in much the same manner one may suppose it always has, living if it can, because it can.

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THE SNOWY OWL INVASION OF OHIO IN 1930-1931

BY LAWRENCE E. HICKS

The Snowy Owl (*Nyctea nyctea*) regularly winters far to the south of its breeding range, some birds probably crossing our northern border into the United States every year, though in very small numbers. At more or less regular intervals, the species in its migratory wanderings penetrates far into the northern part of the United States in considerable numbers. Such invasions have occurred in 1876-77, 1882-83, 1889-90, 1892-93, 1896-97, 1901-02, 1905-06, 1917-18, 1926-27, and again recently in 1930-31. Snowy Owls are also known to have entered Ohio in some numbers in 1909-10, 1910-11, 1912-13, and 1921-22.

Huntington (1931) has summarized the theoretical biological, meteorological, and astronomical causes of periodic fluctuations in numbers of a species as presented at the Matamek conference on biological cycles in 1931. Regardless of what these causes may be, there is abundant evidence to show that there are well marked cyclical fluctuations in the abundance of northern mice, lemmings, the arctic ptarmigan, and other animals in the arctic regions which comprise the food supply of the Snowy Owl.

To determine the extent of these periodic southward migrations of the Snowy Owl or to make an approximate estimate of the number of individuals of the species involved, is a gigantic task—one which requires the coöperative efforts of hundreds of field workers in every section of eastern United States and Canada. To make similar observations of the species during the nesting season or throughout the normal winter range would be practically impossible at the present time.

Fortunately, the prey of the Snowy Owl is practically the same as that of the arctic fox. An abundance of the food species is followed by a rapid increase in numbers of both foxes and owls. When the food supply fails, the Snowy Owl apparently migrates southward to areas unaffected by the food shortage while the arctic foxes are quickly reduced in numbers by starvation and trapping in large numbers.

The dates of the Snowy Owl invasions as recorded in ornithological publications synchronize almost perfectly with reported fluctuations in numbers of arctic foxes. A record catch of foxes by Canadian trappers is followed by a definite invasion of Snowy Owls. These paired maximums and invasions occur at intervals of three to five, but usually, four years. Gross (1931) has compared the dates for Snowy Owl invasions with the years of maximum numbers of arctic

foxes as determined by Mr. Charles Elton, of Oxford, England, who tabulated the number of arctic fox pelts sold by trappers at the Fort Chima post of the Hudson Bay Company from 1872 to 1930.

Dr. Gross lists 1909, 1913, and 1921 as years in which arctic foxes reached maximum numbers but with no known definite accompanying Snowy Owl invasion. Many specimens of the species, however, were taken in Ohio during the winter of 1909-1910 and 1912-1913 and at least one specimen during the winter of 1921-1922. Thus, we see that the records for at least forty years indicate a very definite relationship between the maximum number of arctic foxes and the Snowy Owl invasions (and the abundance of animals comprising the food supply of both species).

During the winter of 1930-1931 from the beginning of the Snowy Owl invasion, the writer endeavored to compile as complete a list as possible of all Ohio records. All taxidermists of the state were notified of the work and requested to mail in records. The aid of each of approximately seventy game protectors of the Ohio Division of Conservation was solicited. A large number of records came from this source, as many protectors interviewed fifty or more observers in their county territory concerning the presence of "white owls". During the winter season, the writer personally visited and engaged in other ornithological research in fifty-nine of the eighty-eight counties of the state, interviewing some 320 observers concerning records. In addition numerous notices were published in local and state papers and 195 questionaires were mailed to ornithologists of the state, including all Ohio members of the Wilson Ornithological Club.

The response of these efforts was most encouraging, splendid coöperation on the part of everyone concerned making it possible to tabulate what certainly is one of the most complete numerical counts ever made in an area of state size. More than three-fourths of the records were received from two or more sources and the capture of one bird was actually listed in twelve different reports. The writer wishes to acknowledge his indebtedness to the several hundred coöperators who so willingly furnished information.

The figures tabulated below certainly do represent a rather high percentage of all birds actually observed or captured by man in the state during the invasion. How many more actually crossed our borders but escaped detection, we can only surmise. Because of the economic depression, many hunters could not afford to pay for the mounting of birds shot or trapped. Several taxidermists reported a big decrease in receipts and many birds left for mounting uncalled for.

Certainly a much larger percentage of Snowy Owls captured failed to find their way to taxidermists (the best source of records) than in former years. Also the Snowy Owl invasion of 1926-27 made mounted birds so common that they were no longer valued by sportsmen and rural people as unusual or valuable prizes.

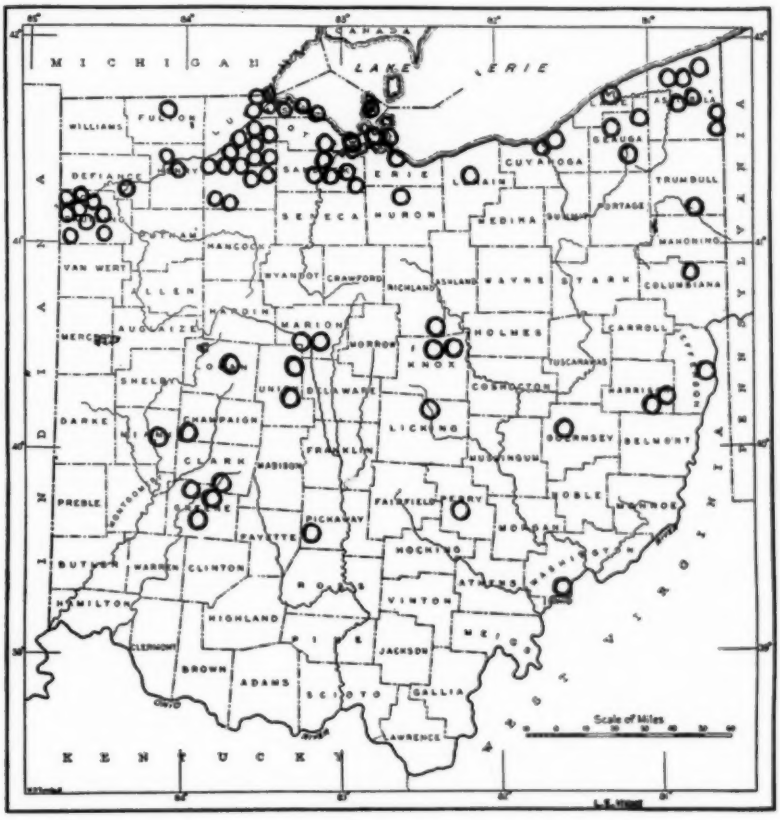

FIG. 55. Snowy Owl Invasion of Ohio in 1930-31.

Gross (1927 and 1931) records 2363 Snowy Owls reported in the United States during the 1926-27 invasion and 1313 birds in southern Canada and the United States in 1930-31. Ohio reported 138 birds in 1926-27 (Thomas, 1928) and 126 in 1930-31. Numbers reported in some other states during the two invasions are as follows: Maine, 589-59; Massachusetts, 294-53; Connecticut, 58-16; New York, 495-63; Michigan, 592-29; and Minnesota, 103-44. Exclusive of Ohio records, and considering only the actual number of birds reported which is

thought to be representative of the total migratory movement, the 1930-31 invasion was only about one-sixth as large as the 1926-27 invasion. This would hardly seem true of Ohio. In 1926-27 the species received wide-spread publicity in the state and the 138 records compiled by Mr. Thomas certainly are fairly representative of the actual numbers present at that time. With nearly as many birds (126) reported in 1930-31, it would seem that this recent invasion must have been at least half as large as the first. Also, the height of the invasion, considering the whole of eastern United States and Canada came near the middle of November in both cases. The height in numbers in Ohio, as determined by Mr. Thomas in 1926-27, took place about December 15, while the height in 1930-31 did not occur before January 10. This very considerable variation in the date of appearance in maximum numbers is indeed interesting. Its significance, though perhaps of importance, is hardly evident at the present time.

Mr. Thomas lists 138 records from 83 localities and 36 counties; the present list includes 126 records from 82 localities and 34 counties. In 1926-27, 92, or 67 per cent, of the birds reported were killed or captured while in the recent invasion only 51, or 40 per cent, suffered the same fate. This, perhaps, is largely due to the fact that the height of the migration came nearly a month later in 1930-31 or mostly following and not during the hunting season. Also, in 1926-27 most of the birds reported appeared to be in a somewhat dazed condition and not at all at home in their new environment. Many were absolutely without fear and others appeared sick. Numerous birds at that time were captured by hand, flying into automobiles or attracted by bright lights. A number were struck down by railroad locomotives, picked up while in an exhausted condition or found in some unusual situation which hardly seemed a logical stopping place for a normal bird of prey. Of eleven stomachs examined by the writer at that time, ten were entirely empty while one contained a small quantity of chicken feathers. Nearly all birds handled were considerably emaciated.

In 1930-31 records of birds taken under unusual conditions were very few. Most birds captured or observed appeared normal in every respect and not dazed or emaciated but as much at home as our native owls. This undoutedly accounts for a much lower percentage of the birds being killed or captured and leads me to believe that in Ohio, and perhaps elsewhere, the 1930-31 invasion did approach that of

1926-27 in numbers much more closely than the figures actually reported would indicate. In 1930-31 a large number of the records listed were of birds reported to have been present in some particular locality for from two to nine weeks, the birds being observed almost daily hunting over stubble fields or bottom lands where meadow mice were abundant. All observers questioned were of the opinion that certainly a large percentage of the birds of this recent invasion did succeed in returning to northern regions in the spring, escaping the tragic fates of most of the owls of 1926-27. Of nine stomachs examined in 1930-31, all but one contained some food, including two Bob-whites, parts of a Ring-necked Pheasant, a sparrow, remains of a Hungarian Partridge, one rat, bits of two chickens, and eight mice.

COMPARISON OF SNOWY OWL INVASIONS IN OHIO

	1926-27	1930-31
Counties of Ohio reporting Snowy Owls	36	34
Number of localities reporting Snowy Owls	83	82
Number of individuals reported	138	126
Number of individuals killed or captured	92	51
Percentage of total number killed or captured	67%	40%
Number of individuals in northern third of Ohio	100	101
Date of earliest record	11-3-26	10-15-30
Height of migration	12-15-26	1-12-31
Date of latest record	5-14-27	5-12-31
Number of individuals reported by months—		
October	0	2
November	25	5
December	49	19
January	6	39
February	11	33
March	5	6
April	1	4
May	1	1

The distribution of records received, as the map shows, was northernly, four-fifths of the returns being from the Lake Erie counties or the counties of northwestern Ohio along the Maumee River, especially Paulding, Defiance, Henry, Lucas, Wood, Ottawa, Sandusky, Erie, and Ashtabula Counties. Few birds penetrated to the southern part of the state but records were much commoner throughout central Ohio than in a belt from twenty to sixty miles south of Lake Erie. On the whole the distribution of records is remarkably similar to that of the 1926-27 invasion.

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Ohio Division of Conservation.
Bureau of Scientific Research.
Columbus, Ohio.

THE CORMORANTS OF SOUTH DAKOTA

BY ARTHUR LUNDQUIST

For a number of years Double-crested Cormorants (*Phalacrocorax auritus auritus*) have nested on the islands of Waubay Lake, Day County, South Dakota. Waubay Lake is about five miles northwest of the city of Webster. The islands on Waubay Lake are small. The east island contains about one acre. The west island is only about one-half this size. There are no trees so that the nests of cormorants are built on the rocky points or on the sandy soil.

Besides the cormorants, Ring-billed Gulls, Common Terns, and a few ducks may also be found nesting. The gulls number about two hundred pairs, the terns perhaps somewhat more than this.

The size of the cormorant colony has varied somewhat from year to year. Also the birds have shifted from one island to the other, depending on the depth of water, etc. The drouth of the past few years has undoubtedly forced many birds in other regions to hunt new grounds and many of these may have joined the Waubay Lake colony. In 1931 the colonies on the east and west islands on South Waubay Lake numbered at least seven hundred pairs. This is perhaps the largest colony of this species within the United States.

Young birds may be found in the nest from the middle of May until into September. New nests are built and birds hatched throughout the summer. I am inclined to believe that these late nests are built by birds that have had unsuccessful nesting elsewhere.

I have visited the colonies at least once during the nesting season for the past seven years. During the past three seasons, I have banded a number of the young. The returns show the range of the bird to be about as reported by Lewis.[1] Also one can not make a rule as to time of migration. Birds may be in South Dakota at the last of November or in Louisiana and Texas by October first.

In all I have banded 1175 cormorants. Each year I have tried to make a late visit to the colonies to check the birds which may die on the island. Nesting as closely as they do here a number of birds are killed each year because of crowding. When the birds are old enough to waddle out of the nest, I have found that if frightened the birds will bunch closely and those unfortunate enough to be under the pile die of suffocation. Twenty-six banded birds were found dead in the three years. I believe crowding to be the chief cause of their death.

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[1]Harrison T. Lewis, The Natural History of the Double-Crested Cormorant. Ottawa, Canada, 1929.

FIG. 56. The Double-crested Cormorant colony on the island in Waubay Lake, S. D. Photograph by the author.

FIG. 57. Closer view of the birds. Photograph by W. F. Kubichek.

Fig. 58. Various views in the Waubay cormorant colony. Photographs by W. F. Kubichek.

The hunter takes the greatest toll of cormorants. During the three years 169 birds have been reported dead by states as follows: South Dakota, 79; Minnesota, 19; Louisiana, 28; Iowa, 8; Nebraska, 3; Missouri, 7; Kansas, 3; Arkansas, 6; Tennessee, 1; Illinois, 3; Texas, 3; Oklahoma, 2; Mississippi, 3; Alabama, 1; Wisconsin, 1; Province of Manitoba, 1; Republic of Cuba, 1. I do not know whether the report from Cuba is unusual or not. I must admit I was somewhat surprised to receive it.

During the summer of 1929, birds were banded in the nest in June, July, and August. Looking over the notes it is apparent at a glance, that the reports of dead birds are much more numerous in the late banding of August birds.

The records show that 314 birds were banded in June. During the fall of 1929 and January of 1930 I find 34 of these reported dead, or 10.8 per cent of the number banded. In July, 61 were banded with 9 or 14.75 per cent dead that fall and winter. In August, 107 were banded with 36 or 33.64 per cent reported dead.

The recoveries from the June group were divided between nine states from South Dakota to Louisiana. The recoveries from the August group were as follows: South Dakota and South Dakota-Minnesota boundary lakes, 30; Arkansas, 2; Nebraska, 2; Oklahoma, 1; Louisiana, 1. Birds in the August group were killed in South Dakota from September 16 until November 28. The chain of lakes in eastern South Dakota is well known for its duck hunting so that there are many hunters in this area.

One may assume that many of the birds which were unable to fly when banded in August were but poor flyers when the hunting season opened on September 16. Also, these birds were not prepared to migrate and therefore were forced to run the gauntlet throughout most of the season in a heavily hunted region.

More than one-third of the August nestlings does seem to me a large number to shoot just for the fun of shooting.

Peabody Hospital,
Webster, South Dakota.

THE WILSON BULLETIN

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EDITORIAL

We Are Happy to Present in this issue a paper by Dr. Frank R. Lillie, the distinguished embryologist of the University of Chicago, and author of one of the best books on avian embryology, "The Development of the Chick". This article penetrates into the problem of the physiological causes of the color pattern of the feather. While the color pattern of the individual feather may be determined by hormones, as Dr. Lillie and his colleagues have shown, one may wonder if these internal factors are sufficient to account for plumage pattern, or whether the latter is due in part to the operation of natural selection, also. It may still be possible that, after the color pattern of the feather has been determined by internal processes, natural selection may play a part in the elimination or survival of the organism possessing it. What external factors may lie behind the variation in quantities of hormones in nature, to bring about the varying color pattern? Or, is there less fluctuation in color pattern than has been supposed, and more orthogenetic evolution, depending directly upon internal factors? Many of our readers are *field* students of birds, but we believe that they will be interested in this glimpse at the experimental aspect of the biology of birds.

The most promising field for research in biology today is in the direction of animal activity, physiology, behavior, etc. Anatomy and classification have had their day—these subjects are not being emphasized in modern biological research. Only here and there are morphological problems of importance found. There may still be some discoveries concerning the relationships of the larger groups; but most of the systematists of today are driven to the work of making subspecies, the biological significance of which is doubtful. And all of these taxonomic problems can be taken care of by a relatively few specially trained men. This is a narrow field for the average man with an interest in ornithology. The young man who looks forward to a professional career in ornithology would do well to consider the field of experimental laboratory work in development; or the field of economic ornithology and game management; or the field of animal be-

havior and psychology, including territory problems. In preparation for these pursuits the student will need all the biological training he can get, including psychology, physiology, ecology, systematic botany, entomology, etc., and chemistry.

Modern studies in animal behavior should be carried out first under natural environment in the field, as far as possible; then results and conclusions should be checked in the laboratory, as far as possible. Field study and laboratory study must go hand in hand in the solution of many modern biological problems; and this will be true in ornithology, as well as in the study of most other special groups. As an example of the way these two methods may be applied we call attention to the study of the Great Horned Owl, by Dr. Paul L. Errington, in this issue. The opportunity for research in the physiology and behavior of birds, as indicated by the papers of Dr. Lillie and Dr. Errington, is unlimited.

Since the preceding lines were written we have received the paper by Baldwin and Kendeigh on "Physiology of Temperature of Birds", reviewed in the pages of this issue of the BULLETIN. Here is another outstanding field of study for the biological ornithologist. The work which is being done at Mr. Baldwin's research station is indicative of a new horizon and a new opportunity. The remedy for the subspecies fad will be found in these new fields of endeavor. Nothing is likely to give better scientific results than a combination of field study with laboratory checks and experiments.

AN EFFORT is being made to locate and list all existing sets of the old *Iowa Ornithologist*, published between 1894 and 1898. Those who possess sets of this early publication will confer a favor by informing Mr. Fred J. Pierce, Editor of *Iowa Bird Life*, Winthrop, Iowa.

GENERAL NOTES

Conducted by M. H. Swenk

The Yellow-throated Vireo in South Dakota.—The writer has found that the Yellow-throated Vireo (*Vireo flavifrons*) is not a rare migrant in South Dakota, but was not convinced that the bird was a summer resident until July, 1932. Early in July, 1931, this vireo was found near Yankton, South Dakota, but I was unable to secure the bird. On July 4, 1932, however, several singing birds were seen and one was collected to dispel any doubt as to the record. This bird was examined and considered to be a breeding bird, and this adds another species to the list of summer residents of southeastern South Dakota.—William Youngworth, *Sioux City, Iowa.*

Nesting of Prairie Warbler Two Years in Identical Location.—During the past few years the Prairie Warbler (*Dendroica discolor*) has become a fairly common summer bird in Upshur County, West Virginia, but it was not until 1930 that a nest was found. One was located in June of that year, near French Creek. The nest was placed in a small apple tree in a brushy pasture, and on June 23 contained three eggs. Rearing was never completed, however, for some prowling animal broke up the nest, and, although the birds were still singing in the neighborhood, we could not find out if they built again.

The birds returned in the summer of 1931, and on the evening of July 2, as we were passing through the same pasture, curiosity prompted us to walk over to the scrub apple tree where the nest had been found the previous year. Much to our surprise, we found another nest, containing three eggs also, and located in almost exactly the same place as that chosen the preceding season.

Bad luck attended this nest also, for it too was broken up before the eggs hatched. We are wondering if the third attempt will be made, or if the spot will be abandoned as definitely unlucky.—Maurice Brooks, *French Creek, W. Va.*

Wilson's Snipe Feeding in Open Water.—On November 17 and 18, 1923, I observed two Wilson's Snipes (*Capella gallinago delicata*) feeding in shallow water in the lake at Englewood Dam, Montgomery County, Ohio. They were well out from the shore, among several small gravelly islands that were devoid of all vegetation. A single Pectoral Sandpiper was their companion on both occasions.

My notes pertaining to the snipes, recorded at the time, read in part: "Frequently they were observed feeding in water up to their bodies. As one crossed from a small island to another about thirty feet away, it to all appearances swam a few yards and then took wing, apparently from water too deep for it to stand in. I observed these birds at about twenty-five yards with 8x glasses as they probed about in the water, and at this distance they were not disturbed at my presence. Nearer approach caused them to fly only a short distance, usually to a sandbar in shallow water. Once one flew to the muddy shore and disappeared in the marginal vegetation."

It was observed that the characteristic "*scaipe*" note was uttered when the birds took wing on being disturbed by my movements, but it was not uttered when the birds flew of their own accord. Often they squatted motionless in the water, apparently a response to the concealment instinct which is so effective when the bird is on land. Although Wilson's Snipe is common here during the migrations this is the only instance I have observed of its feeding sandpiper-fashion in open water.—Benjamin J. Blincoe, *Dayton, Ohio.*

The Orange-crowned Warbler at Ann Arbor, Michigan.—On January 31, 1932, an Orange-crowned Warbler (*Vermivora celata*) came to the feeding shelf at my home and was discovered quietly eating suet in a banding trap. It was apparently a female, for close examination revealed but a slight trace of orange on the crown. The bird seemed to be in good condition and was banded and released. This is the first winter record we have for Michigan.

Barrows (Michigan Bird Life, pp. 587-8, 1912) listed very few records for the state, and considered it more rare than our present knowledge would indicate. Norman A. Wood (Auk, xl, p. 338, 1923) and Walter Koelz (Wilson Bulletin, xxxv, pp. 39-40, 1923, and Auk, xli, pp. 617-18, 1924) have added a few records, but we now have so much additional data that it seems worth while to summarize our knowledge of the species in the Ann Arbor region.

I have listed below only records for Washtenaw County and, except as otherwise specified, all records refer to Ann Arbor. These records are based largely on specimens in the University of Michigan Museum of Zoology and the records of my friend Mr. A. D. Tinker whose field of experience in this region is unequaled.

Spring:

1869. April 24—male collected by M. W. Harrington.
1902. May 14—male collected by N. A. Wood.
1904. May 10—male collected by N. A. Wood.
1905. May 13—female collected by N. A. Wood.
1911. May 1 —one seen by N. A. Wood.
1912. May 5 —one seen by A. D. Tinker and Frank Novy.
May 6 —male collected and two others seen by N. A. Wood at Portage Lake.
1917. May 17—one seen by N. A. Wood.
May 23—two seen and a female collected by Walter Koelz.
1918. May 11—male collected by Dr. Max M. Peet at Delhi .
May 14—one seen at Ann Arbor by A. D. Tinker.
1919. May 3 —one collected by Walter Koelz.
May 4 —two seen by A. D. Tinker; also one on May 13.
1920. May 11 to 13—"abundant at Ann Arbor", Walter Koelz (Wilson Bulletin, xxxv, p. 40).
1921. May 8 —one seen by Walter Koelz.
1922. May 12—one seen by Walter Koelz.
1923. May 13—two seen by A. D. Tinker.
1924. May 3 —one collected by Walter Koelz. "From the 8th to 12th they were most numerous when four or five were seen daily. The last specimen was noted on the 25th," Koelz (Auk, xli, p. 618).
1926. May 2 —one seen by A. D. Tinker; also seen on May 4, 7, 9 (two), and 11.
1928. May 5 —three seen by A. D. Tinker.

Autumn:

1887. October 6—three collected by Dr. A. K. Fisher at Ann Arbor (recorded in a letter of March 10, 1908, to B. H. Swales).
1896. September 10—male collected by Will MacLean.
1906. October 3 —male collected by N. A. Wood at Portage Lake.
1913. October 19—one seen by A. D. Tinker.
1916. September 13—three seen by A. D. Tinker.
1921. September 25—one seen by A. D. Tinker; also one on October 9.
1923. October 14—one seen by A. D. Tinker.
1925. October 4 —three seen by A. D. Tinker. Another seen by him on November 1, although there had been snow and a temperature of 20° on October 29.

The latest autumn record for Michigan is that of a male collected by Walter Koelz (Wilson Bulletin, xxxv, p. 40, 1923) on November 27, 1917, at Waterloo, Michigan (not Ann Arbor as reported in the Auk, xl, p. 338).—Josselyn Van Tyne, *Museum of Zoology, Ann Arbor, Mich.*

A Cardinal's Odd Way of Catching Ants.—This incident concerning the Eastern Cardinal (*Richmondena cardinalis cardinalis*) was related to me by a friend, Mrs. Mary Heath Lee of Fairhope. Mrs. Lee is a very careful observer. She says: "Hearing a pattering on my porch one morning (early in July) I looked out quickly. Cardinals were frequently about but they seldom came nearer than the drinking-bowl in the yard. But there was one (a male) on the porch investigating a dead cockroach. There was really very little of the insect left, but it was surrounded by ants. The Cardinal first picked the ants from the cockroach's body and then from the porch floor. Probably with its broad beak the bird found it difficult to pick up the ants. I was not near enough to see. But it began walking back and forth, dragging its tail alongside, with the underside uppermost, and though this was almost too much for its balance, it managed to stand and pick from the underside of its tail the ants it had thus swept up."—HELEN M. EDWARDS, *Fairhope, Ala.*

The Record of the Starling in Arkansas.—In W. J. Baerg's recent "Birds of Arkansas", published in January, 1931, the record of the European Starling (*Sturnus vulgaris vulgaris*) is given as from Fayetteville, and under date of January 25, 1930. This same source also states that this is the only record for the state. Both of these statements are incorrect. Furthermore the Fayetteville record is based on a rather uncertain sight observation, and could not be accepted in any form except for the work of Mr. S. H. Weakly of Fort Smith, who established the true state record January 18, 1930. On that date Mr. Weakly trapped and banded the first Starling taken in the state, according to all available information. This bird was banded with Biological Survey band No. A239438. Three days later Mr. Weakly banded four of the birds, with bands No. A239474-75, A239495-96, and a sixth bird, No. A350691 on the following day. Since that time and ending February 19, 1930, Mr. Weakly has banded twenty-three more of the birds, for a total of twenty-nine from Fort Smith during the winter of 1929-30.

Of the above Mr. Weakly has received two returns, one No. A239476 (banded January 21, 1930) being found dead by C. E. Dennis, in Moultrie County, Illinois, March 3, 1930, and another No. A350721 (banded February 6, 1930) captured and released by M. Chambers at Athens, Illinois, January 19, 1931.

Mr. Weakly has been kind enough to furnish me with his records to supply the above information, which establishes beyond question the state record. He adds in his letter to me with the above information and records (June 6, 1932) that: "Starlings were fairly plentiful here during the winter of 1928-29, extremely plentiful in 1929-30, very few in 1930-31, and lots of them last winter, but the weather was so mild and feed so abundant that I did not band a single one, although they fed in my garden among my traps."

It is evident from the above that Mr. Weakly had established a sight record for the Starling at least a year before banding a single individual, and that the Starling can no longer be considered as accidental, but as an established winter resident in Arkansas. It might be added that Fort Smith is on the extreme western border of the state, and it is quite probable that the birds are locally even more common at certain places on the eastern side of the state.—J. D. BLACK, *University of Kansas, Lawrence, Kan.*

American Egret in Lake County, Indiana.—A flock of four Egrets (*Casmerodius alba egretta*) were seen July 29, 1932, two miles west of Merrillville, Lake County, Indiana, by Mr. W. C. Nelson and the writer. These birds, in a small marsh, seemed not at all disturbed by the passing of automobiles on one of the principal highways less than 100 yards away.—PHILIP A. DUMONT, *Des Moines, Iowa.*

Some Iowa Birds in a Des Moines Collection.—While recently examining several collections of birds from Central Iowa, a number of specimens were found in the collection of Mr. D. J. Bullock of Des Moines, which are unusual enough from Iowa to warrant publication.

Mr. Bullock secured these birds principally in Story County, Iowa, but specimens are represented from Jasper, Polk, Hamilton, Grundy, Hancock, and Dickinson Counties, as noted below. The bulk of the specimens have been taken since 1927, but a few (from Jasper County) were collected in 1900-01. At the present time the collection has been loaned to the Des Moines Public Schools and it is kept in the Washington Irving Junior High School. Mr. Bullock has kindly allowed me permission to publish these records.

Horned Grebe (*Colymbus auritus*). One killed in October, 1928, at Eagle Lake, Hancock County. This and the next species were secured at the same time.

American Eared Grebe (*Colymbus nigricollis californicus*). Four specimens taken at Eagle Lake, Hancock County, during October, 1928. Bullock reported these two species as abundant, but as all of the specimens are in winter plumage it would be difficult in the field to determine the number of each that were present.

White Pelican (*Pelecanus erythrorhynchos*). One bird out of a flock of six was killed at Little Wall Lake, Hamilton County, in September, 1929.

Double-crested Cormorant (*Phalacrocorax auritus auritus*). Two specimens from Story County taken in October, 1927. Reported as a fairly common fall migrant.

Hutchins's Goose (*Branta canadensis hutchinsi*). A large flock of between fifty and seventy-five was seen in Story County during October, 1927. Of the two specimens secured one is preserved in this collection. This is the smaller of the three forms of Canada Geese visiting Iowa, hardly larger than a drake Mallard.

Lesser Snow Goose (*Chen hyperborea hyperborea*). Two killed out of a flock of seven in Story County, March, 1928. Both are now in this collection.

Blue Goose (*Chen caerulescens*). One bird collected in Story County during November, 1927.

Hooded Merganser (*Lophodytes cucullatus*). A male taken at Little Wall Lake, Hamilton County, in October, 1929. Bullock states that small flocks are common during fall migration in this locality.

American Merganser (*Mergus merganser americanus*). A male and female collected at Little Wall Lake, Hamilton County, during September, 1929.

Swallow-tailed Kite (*Elanoides forficatus forficatus*). An adult taken in Jasper County during the fall of 1901. This is the only record Bullock has of this species.

Eastern Goshawk (*Astur atricapillus atricapillus*). One taken in Jasper County during the winter of 1901.

Harlan's Hawk (*Buteo borealis harlani*). There is one specimen taken in Polk County during October, 1930, which shows the typical black streaking on the reddish-black tail.

Rough-legged Hawk (*Buteo lagopus s.-johannis*). There are three specimens from Story County taken in November, 1927. One of these is in the light phase, one in the dark and the third in an intermediate plumage. Another specimen in the dark phase was taken during the winter of 1930-31 in Polk County.

Osprey (*Pandion haliaetus carolinensis*). One taken in Grundy County during the fall of 1927.

Prairie Falcon (*Falco mexicanus*). A specimen of this rare straggler in Iowa was secured by Bullock in Story County during the fall of 1927. The bird is in adult plumage and judging from size should have been a female.

Eastern Ruffed Grouse (*Bonasa umbellus umbellus*). There is a male and female taken in Jasper County in March ,1901.

Greater Prairie Chicken (*Tympanuchus cupido americanus*). Two specimens secured from a flock of fifteen or twenty birds seen in Story County in December, 1927.

Yellow Rail (*Coturnicops noveboracensis*). Two killed in Story County during September, 1928. Bullock says that this species is rather scarce in the marshes near Ames.

Herring Gull (*Larus argentatus smithsonianus*). Two killed out of a flock seen in Story County during March, 1928.

Ring-billed Gull (*Larus delawarensis*). Four specimens taken at Eagle Lake, Hancock County, October, 1928. Bullock states that this gull was present in goodly numbers at that time of year and he has found that it always out-numbers the Herring Gull in Story County.

Franklin's Gull (*Larus pipixcan*). Four collected at Eagle Lake, Hancock County, in October, 1928. All are in winter plumage.

Bonaparte's Gull (*Larus philadelphia*). One in winter plumage collected at Spirit Lake, Dickinson County, October, 1931. Bullock reported them as numerous at that time.

Great Horned Owl (*Bubo virginianus virginianus*). One with two nestlings was taken in Story County during March, 1927. Bullock considers this species fairly common in Polk County. At least twenty were seen during the winter of 1930-31 and one specimen secured.

Montana Horned Owl (*Bubo virginianus occidentalis* Stone). There is one specimen taken in Story County during January, 1927, which must be referred to this subspecies. Bullock states that the bird was killed during a severe spell of cold weather. Inquiry showed that weather north had also been extreme with much snow and ice. The bird was in very poor condition and appeared exhausted.

In this specimen the dark cross bars on the white belly are distinct and uniform, not clouded as in *B. v. occidentalis*. The whitish feathering of the tarsi is without barring, and the facial disk is of a uniform grayish without tawny markings.

The range for this subspecies as given in the A. O. U. Check-List, 4th Edition, 1931, states that it is found in winter south to Nebraska and Wisconsin, not mentioning Iowa.

Snowy Owl (*Nyctea nyctea*). One secured in Jasper County during December, 1900.—PHILIP A. DUMONT, *Iowa City, Iowa.*

New Birds for State College, Pennsylvania.—In 1909, at State College, which is near the geographical center of Pennsylvania, Mr. J. K. Musgrave wrote a thesis on the birds of that region. He listed 146 species of which six have not been recorded there again. They are Red-throated Loon, two collected; Green-winged Teal, one collected; Golden Eagle, two collected; Brunnich's Murre, one collected in the winter of 1894 or 1895 (this specimen is in the oology collection of the Pennsylvania State College); Snowy Owl, one collected in January, 1891; and Blue-winged Warbler.

Since 1909 nearly a dozen people, studying or teaching in the College, have recorded their observations, until today 217 species are listed for the place. Mr. Thomas D. Burleigh, of the Biological Survey, published in numbers of the WILSON BULLETIN for June and September, 1924, and March, 1931, a very comprehensive report. Mr. R. C. Harlow has similar articles in the *Auk* of January, April, and July, 1918, but aside from his nesting data the only species not covered by Mr. Burleigh are Saw-whet Owl, Acadian Flycatcher, and Short-billed Marsh Wren.

The following are the species new to State College and vicinity since Mr. Burleigh's report:

Black-crowned Night Heron. One seen May 30, 1930, at Oak Hall (Dr. Haskel B. Curry).

Eastern Least Bittern. Seen September, 1930, at Oak Hall (Curry).

Wood Duck. One female seen in Alan Seeger Forest (Mr. George M. Sutton).

Ring-necked Duck. One seen May 4, 1932 (Dr. Thomas C. Benton).

Canvas-back. One injured female captured alive by a farmer, in November, 1931 (Merrill Wood).

Lesser Scaup Duck. First noted in the fall of 1926 (Mr. J. Warren Large). Seen each spring thereafter.

American Merganser. One seen April 11, 1932 (Benton and Wood).

Rough-legged Hawk. One seen November 10, 1929, over the College farms (Curry).

Ring-necked Pheasant. Introduced in 1925.

Barn Owl. One captured alive on December 10, 1928 (Miss Marjorie R. Ross), and one seen October 4, 1931 (Wood).

Long-eared Owl. One collected in 1925 by a local resident (Wood).

Fish Crow. Seen and heard throughout the year (Wood).

Eastern Mockingbird. One appeared in town November 13, 1929, and remained there until December 14, 1929 (Wood). Said to have been seen once again on January 20, 1930.

Blue-gray Gnatcatcher. One seen spring of 1927 (Large), two seen May 18, 1930 (Curry and Wood), and one seen May 11, 1931 (Curry and Wood).

Northern Shrike. One seen on March 27, 1926 (Large), and one seen November 23, 1930 (Curry).

White-eyed Vireo. One seen in the spring of 1927 (Large).

Philadelphia Vireo. One seen on September 21, 1930 (Curry).

Western Palm Warbler. One seen May 11, 1931 (Curry and Wood).

Kentucky Warbler. One seen May 8, 1927 (Ross).

Boat-tailed Grackle. Seen spring of 1927 at Oak Hall (Large).

Eastern Evening Grosbeak. Four seen April 13, 1930 (Wood).

Canadian Pine Grosbeak. Seen May 1, 1926 (Large), nine seen January 25, 1930 (Wood), and six seen March 30, 1930 (Wood).

Eastern Lark Sparrow. One breeding record, including nest, June 27, 1931 (Miss Farida Willey), published in the *Auk* for January, 1932 (Wood).

Lincoln's Sparrow. Seen September 28, 1929 (Curry), and September 21, 1930 (Curry), and two seen October 4, 1931 (Wood).

The following are some records that are perhaps noteworthy:

Baldpate. One seen April 11, 1932, and a pair seen May 14, 1932 (Wood), the first to be seen since 1909.

Old-squaw. One seen April 21, 1932, at Oak Hall (Wood); only one other record.

Eastern Screech Owl. Still all of the gray phase.

Red-bellied Woodpecker. One seen January 24, 1924 (Large); only one other record.

Northern Cliff Swallow. Colony of forty-two nests in use found May 25, 1930, at Pennsylvania Furnace (Wood).

Northern Blue Jay. A flock of sixty-five counted near Shingletown, September 27, 1931 (Wood).—MERRILL WOOD, *Harrisburg, Pa.*

Brunnich's Murre in Iowa.—Mr. Frank C. Pellett has recently placed in the hands of the writer a specimen of Brunnich's Murre (*Uria lomvia lomvia*), which he secured at Atlantic, Cass County, Iowa, on December 16, 1896, this being the date given on the original label attached to the specimen. A note referring to this specimen was published by J. H. Brown in the *Iowa Ornithologist* (III, No. 1, p. 11, January, 1897); but it was here reported as "probably the Atlantic form, Uria troile, Linn.", and as "captured alive, but thoroughly exhausted, Dec. 20th near Atlantic and died soon after". Dr. R. M. Anderson, in "The Birds of Iowa" (1907), includes this specimen in his account of *Uria lomvia*, though probably by inference rather than examination, since Mr. Pellett has no knowledge that it was examined at this time. The *Auk* for 1897 contains numerous records of this species for the interior of the continent. It is evident that a flock of considerable size must have been blown inland to lose their bearings. A comparison of these dates indicates that December 16 must have been rather early for a point so far inland as Iowa, while December 20 would be quite comparable; however, the difference is slight. To make quite certain of the identification we recently sent the specimen to Mr. Ludlow Griscom, of the Museum of Comparative Zoology, Cambridge; and we are indebted to Mr. Griscom for verifying our belief that the specimen is *lomvia*—"a young Brunnich's Murre of the year", as he states.—T. C. STEPHENS, *Sioux City, Iowa.*

Another Hybrid Between the Indigo and Lazuli Buntings.—Walter J. Breckenridge of the University Museum, University of Minnesota, has the credit of collecting, in northwestern Minnesota on June 26, 1929, the first male hybrid between the Indigo and Lazuli Buntings (*Passerina cyanea* x *P. amoena*). On June 1, 1932, the writer took a similar hybrid bird, while working in Cherry County, Nebraska, under the direction of Fred M. Dille, of Rapid City, South Dakota. The country bordering the swift Niobrara River in Cherry County is ideal for the summer home of grosbeaks and buntings. The Indigo Bunting is a fairly common bird in this region, and here also we found several Lazuli Buntings settled for the summer. Beautiful Black-headed Grosbeaks, Western Blue Grosbeaks, and Scarlet Tanagers were found not uncommonly, with a single Cardinal adding more color to this highly-colored group of species.

A typical Indigo Bunting song was heard early on the morning of June 1, and, needing another specimen, the writer located the bird with his glasses and at once noted the odd markings of the bird, which was taken, later dissection showing it to be in breeding condition. Both J. M. Linsdale and W. J. Breckenridge, respectively of the University of California and University of Minnesota, have examined the specimen in question, and evidence points to mixed ancestry of the bird, with characters of the two species about equally well marked. A fine description of a hybrid bunting is given in the Occasional Papers Number 3, of the University of Minnesota, Minneapolis, Minnesota, 1930.—William Youngworth, *Sioux City, Iowa.*

The Bohemian Waxwing in Arkansas.—On May 6, 1931, G. A. Winn, a local banker whom I consider to be a very careful observer, reported the presence on his farm of four birds that he had watched eating apple buds that morning, and which answered to the description of the Bohemian Waxwing (*Bombycilla garrula pallidiceps*). I was satisfied in my own mind at the time that the birds were Bohemian Waxwings, but was fortunate enough to establish beyond doubt the truth of this six days later, when on May 12 I watched a flock of ten of these birds at very close range as they greedily ate the blossoms of a flowering dogwood.

Only one other record for this bird has been made in Arkansas—from Fayetteville in either April or May of 1921, according to the recently published "Birds of Arkansas" by W. J. Baerg. No other reference to the presence of the species in the state can be found, although it is probable that many occurrences of the bird in this section of the state have been overlooked because of the similarity to the very common Cedar Waxwing, which sometimes appears here in large numbers, and is a common winter visitor.—J. D. Black, *Winslow, Ark.*

American Egret in Butler County, Pennsylvania.—Late in the afternoon of August 11, 1932, Adam M. Barker saw a "white" heron at the far side of a large water supply reservoir in central Butler County, Pennsylvania. Efforts to get near the bird were fruitless. The writer accompanied him to the lake to August 13, in an effort to establish the identity of the bird.

About an hour before sun-down, a large white bird flew over from the upper end of the lake. We pursued it downstream and had an excellent view of an American Egret (*Casmerodius alba egretta*) feeding in the shallow margin. The pure white plumage, yellow bill, black legs and the usual midsummer absence of the interscapular plumes, observed at seventy-five yards, left no doubt as to the identity of this summer wanderer from its breeding range.

We visited the lake again on August 20, and were rewarded by seeing the bird in flight. It came halfway down the lake, circled over our heads and disappeared at the upper end of the reservoir where the territory is heavily wooded. Later in the day we found it perched on a tree at the water's edge. A Great Blue Heron, northern cousin of the egret, kept it friendly company from its perch on the limb of a nearby tree.—Sidney K. Eastwood, *Pittsburgh, Pa.*

American Egret in Elkhart County, Indiana.—I wish to announce the occurrence of the American Egret (*Casmerodius albus egretta*) in Elkhart County, Indiana. A single bird was observed August 5, 1932, feeding on Christiana Creek, two miles north of Elkhart. It was observed at a range of seventy-five yards, and the black legs and feet were plainly seen. It was last seen on August 15.—Raymond J. Fleetwood, *Elkhart, Ind.*

ORNITHOLOGICAL LITERATURE

THE BIRDS OF MINNESOTA. By Thomas S. Roberts, M. D. Two volumes. The University of Minnesota Press, Minneapolis, 1932. Pp. i-xxiii+1-691, i-xv+1-821. Ninety-two color plates, 606 text illustrations, five maps. Price, $6.00.

The ornithological students who live in the Mississippi Valley will regard this work with satisfaction and pride, as evidence of the virility and activity of the middle west in this particular branch of natural history. It is a beautiful piece of work mechanically, and a most laudable one textually. While "The Birds of Minnesota" is limited by title to a single state, yet the list of birds and descriptions will fit very closely also the group of states in the upper Mississippi Valley. It is the last word on the ornithology of this region, and is likely to remain such for some time.

Volume One opens with "An Historical and Biographical Review of Ornithology in Minnesota" (pp. 1-18), a subject always of importance to students, and in this case fully and explicitly treated. For our own part we heartily concur in the high estimate given in these pages to the work of Dr. Elliott Coues. The author has been very generous in his acknowledgment of assistance from many sources. In the chapter devoted to geography the author presents an entertaining and instructive account of the topography, vegetation, and climate of the state. Further on are discussed the subjects of life zones, seasonal occurrence, hypothetical species, sight records, game birds and laws pertaining to them, economic value, enemies, parasites and diseases of birds, songs, bird banding, etc., etc. On page 109 the author states that "cats have no legal standing". We had been led to understand otherwise. It is possible that their status varies in different states. We hope that they have no legal status, but would advise our readers to make sure before overtly destroying a trespassing cat that may later be claimed by a neighbor.

The body of the work is a descriptive catalogue of the birds known to have occurred within the state. Most of the specific accounts are presented under the paragraph headings, general range, Minnesota range, migration dates, nests, food, field marks, followed by the author's own copious annotations.

Two hundred and seventy-two pages in Volume Two are devoted to keys and descriptions—a wonderful source of technical information. Fifty-seven pages of bibliography of Minnesota ornithology probably cover the field pretty thoroughly, though the author calls it abridged. The usual index is present.

Volume One contains fifty colored plates, each portraying several species. Volume Two contains forty-two colored plates. Six artists have contributed the plates, viz., Messrs. Allan Brooks, F. L. Jaques, George Miksch Sutton, Louis Agassiz Fuertes, Walter Alois Weber, and W. J. Breckenridge. The last two named are younger artists who are now bidding for honors in this field of work, and we think that they are assured of a position of leadership among bird artists of the time. Mr. Weber's work on the finches and Mr. Breckenridge's work on the sandpipers, just for example, is of a high order in each case. Mr. Jaques' painting of the Great Blue Herons and the cranes is a beautiful thing.

About the only criticism which we feel able to offer is to the effect that the binding seems a little frail for so heavy a volume, and we wonder how long it will hold out with ordinary usage. Such a work as this is usually made possible through philanthropy. And, in this instance a group of Minnesotans, doubtless

friends of Dr. Roberts, made contributions (approximating a total of $30,000, according to a rumor which has reached us) toward the publication of this work. This generosity has made it possible to sell the work at far below cost. We also understand that the edition is rapidly becoming exhausted, which probably accounts for the advertisement of the set at rather high prices in eastern book catalogues.—T. C. S.

THE SLAUGHTER OF THE YELLOWSTONE PARK PELICANS. Issued by the Emergency Conservation Committee, New York. September, 1932. Pp. 1-12.

We regret that this pamphlet is issued anonymously, like others recently put out. Though we profess sympathy with some of the aims of the Committee, we believe that signed articles will be more effective and less open to criticism. The present pamphlet exhibits correspondence which, if authentic, shows what has been taking place and who is responsible. What a shame it is that our national parks can be controlled in any way by commercial interests! There can be no doubt that the Yellowstone Park colony of White Pelicans is being "controlled", though we are not prepared to claim that it is being *reduced* below a certain number from year to year. No doubt the colony would increase if allowed to. We visited the Molly Islands in 1927. The men of the U. S. Bureau of Fisheries who were on the ground at that time were very open in their complaint of the pelicans, and gave the writer to understand that means were being found to keep the numbers down. The pamphlet suggests that the colony is "controlled" by destroying the eggs and clubbing the young birds. We believe the Emergency Committee is doing a great public service in bringing these matters to public attention, but we can not approve the practice of anonymity in the publications. —T. C. S.

PHYSIOLOGY OF THE TEMPERATURE OF BIRDS. By S. Prentiss Baldwin and S. Charles Kendeigh. Sci. Publ. Cleveland Mus. Nat. Hist., Vol. III, pp. i-x+ 1-196, pls. I-V, figs. 1-41, and frontispiece. Cleveland, Ohio, 1932.

In this study of the physiology of the temperature of birds an attempt is made to analyze and determine both the external and internal factors in the control of body temperature, there being a constant interplay between those two sets of factors. The authors have devised new and elaborate mechanisms for their purposes. It was found that temperatures could be determined more accurately, as well as more easily, by thermocouples than by mercury thermometers.

There are many interesting facts connected with the physiology of body temperature of birds. As has long been known in the case of mammals, muscular activity is an important factor in body temperature. The authors think that if the body temperature of birds is higher in the summer than in the winter, the fact is to be explained by greater activity rather than by higher air temperature. Their data also lead to the conclusion that the incubation temperature is uniform throughout, that is, there is no increase in the body temperature of the sitting bird during the latter period of incubation.

The daily rhythm of the body temperature of an incubating bird is represented by a typical sigmoid curve, which seems to be an exaggeration of the corresponding air temperature curve, but is also indicative of relative metabolic activity. Moreover, this sigmoid curve of daily temperature may be reversed experimentally. By keeping birds in the dark during the daytime, thus subduing

normal activity, and then transferring them to a well illuminated room at night, a complete reversal of the temperature curve is effected; which, doubtless, also affects the entire metabolic routine. In the authors' repetition of this experiment they found a tendency toward mortality in the subjects, and suggested that "the reason for their dying may possibly have been a too precipitous reversal of the normal periods of activity". (Pp. 91-92). But if the reasoning here is sound, why should not mammals be similarly affected? And what bearing does all this have upon the night shifts of human labor? Well, who knows? (We note here a typographical error on page 92, line 12, where the figure reference should be 26 instead of 21).

The paper is too long to review thoroughly, but is full of interesting facts, and is another example of the modern trend in biological research, and, we may say, in ornithological research. Here is a great field for the young ornithologist of today.—T. C. S.

LIFE HISTORIES OF NORTH AMERICAN GALLINACEOUS BIRDS, ORDERS GALLIFORMES AND COLUMBIFORMES. By Arthur Cleveland Bent. United States National Museum Bulletin 162. Pp. i-ix+1-490. Plates 93.

This is the ninth of the excellent bulletins on the life histories of North American birds published by the United States National Museum, and follows the same general plan as its predecessors except that the present number combines the nomenclature of the 1931 Check-List of the American Ornithologists' Union with the arrangement of families and species as given in the old (1910) Check-List. Such a combination seems undesirable and likely to produce confusion. Once a nomenclature and arrangement of species and families have been adopted by a nationally recognized body such as the A. O. U., all serious papers in the field should make desperate efforts to conform.

A compilation of this kind and size must of necessity deal largely with generalizations. In this specific case, it is a pleasure to note the many citations of original literature. The stupendous task of collecting together and organizing this mass of notes on life histories has been accomplished in an unusually satisfactory manner. Any criticisms made here should not be allowed to detract from our debt to Mr. Bent and the National Museum for these studies. The 160 halftone illustrations do much to make clear the text. All bird lovers should add this volume to their library while it is obtainable.

When Bent leaves descriptions of behavior and passes to interpretations, he passes into a field where his views can not be accepted with such assurance. For instance, on page 149, he speaks of the female Ruffed Grouse as "teaching them (the young) to scratch and hunt for insects", and later, he says, "they are taught to dust themselves". It may be questioned that the young are actually taught these things. On the other hand they may be doing these things from instinct. The only way to settle a point of this kind is to raise Ruffed Grouse in an incubator and find out whether young so raised dust themselves and scratch or whether they do not. If, when they are raised in an incubator, they scratch and dust themselves, they certainly do this without being taught by their mother. Similar interpretations scattered throughout the paper are subject to the same type of criticism.—JESSE M. SHAVER.

THE DISTRIBUTION OF BIRD-LIFE IN GUATEMALA. A CONTRIBUTION TO A STUDY OF THE ORIGIN OF CENTRAL AMERICAN BIRD-LIFE. By Ludlow Griscom. Bull. Amer. Mus. Nat. Hist., Vol. LXIV, pp. 1-430. New York, 1932.

This excellent study is dedicated to the memory of Jonathan Dwight, Jr., because Dr. Dwight had been deeply interested in the bird life of Central America, and upon whose collections the present report is chiefly based. Without attempting to describe the paper in detail we may say that it deals with the history of the ornithology of the region, with climate, physiography, life zones, and finally, with the distributional list of birds. The work shows all the evidence of being an accurate and authoritative treatise, and will be of great value to all who are concerned with the bird life of Central America.—T. C. S.

THE AUDUBON YEARBOOK (INDIANA) FOR 1932. Published by the Indiana Audubon Society, Indianapolis, 1932. Pp. 1-100. Price, $1.00 (Miss Margaret R. Knox, Sec.-Treas., 4030 Park Ave., Indianapolis, Ind.).

We have learned to look for interesting material within the covers of this annual, and the present one is no exception to the rule. The volume is dedicated to Dr. Amos William Butler, who might be called the Father of Indiana Ornithology, because he began writing on Indiana birds away back in the '80's, and has never since lost his interest in this pursuit; and, in 1897, he published a complete treatise on the birds of Indiana, which has not been superceded as yet. The portrait of Dr. Butler is presented as a frontispiece, and is followed by a biography prepared by the late Dr. Barton W. Evermann, formerly of Indiana. There is also attached a complete bibliography of Dr. Butler's writings up to date. In connection with a short paper by Mr. O. M. Schantz on the sand dunes there is printed a list of the birds of that region. Because of the popularity of the Indiana dunes this list might well be republished sometime in annotated form. Dr. Earl Brooks continues his ana on the Robin, including such topics as unusual nest sites, various psychological traits, intoxication, bigamy, bathing, number of broods, nest parasitism, albinism, melanism, etc. Dr. Brooks' address is Noblesville, Ind. Mr. George Zebrowski presents a very full and instructive paper on the parasites (internal and external) of birds.—T. C. S.

BIOGRAPHICAL MEMOIR OF ROBERT RIDGWAY, 1850-1929. By Alexander Wetmore. Biographical Memoirs, Vol. XV, Nat. Acad. Sci, 1932, pp. 55-101. Washington, D. C.

We find here the most important biography of Mr. Ridgway which has thus far appeared, next to the one by Mr. Harry Harris, published in the *Condor* (January, 1928). We did not realize until we checked up at this time, that no memorial sketch has thus far appeared in the *Auk*. A complete bibliography of Mr. Ridgway's work is given; and one may be surprised to find how interesting a personal bibliography can be.—T. C. S.

THE NEED FOR STUDIES IN BIRD CONTROL IN CALIFORNIA. By W. L. McAtee. Month. Bull. Calif. Dept. Agric., XXI, April-May-June, 1932, pp. 269-286.

It seems strange that so many birds become pests in California. In the present paper birds classified as pests (under certain circumstances in California) include ducks, coots, quail, band-tailed pigeons, horned larks, blackbirds, goldfinches, English sparrows and linnets, Gambel's sparrows, and possibly one or two others. On page 279 the report states that "a survey of 53 orchards has just been

completed which shows an average loss of 10 per cent for 1930". This is about the same estimate of loss that is claimed from insects. So, economically they would not be any worse off if they killed all the birds and kept the insects. The claims made by fruit growers and others are startling enough; but all such testimony may be assumed to be prejudiced, and perhaps exaggerated—and it may only be published as a justification for practices. Action should be based wholly upon the reports of the Survey's men, or others without prejudice. The author concludes with an argument for the use of poison as the method of control. Much effort is being made to show that the poison method is selective and discriminative, that the harmful species and individuals only will take the poison. —T. C. S.

Progress Report of the Ruffed Grouse Investigation. By Gardiner Bump, F. C. Edminster, Jr., Robert Darrow, W. C. Ritter, and A. A. Allen. Reprinted from the 21st Annual Report, for 1931, Conservation Dep't, Albany, N. Y., 1932. Pp. 1-19.

Much attention is being given nowadays to the problems of all species of game birds. Many states are supporting scientific investigation on the habits and requirements of certain species especially desired for hunting purposes. One useful table in this paper shows the nature of the food of the Ruffed Grouse month by month throughout the year; percentages are not given, however. From observations at the disposal of the authors it is concluded that grouse abundance fluctuates on a ten-year cycle.—T. C. S.

Ornithology of the Oneida Lake Region: with Reference to the Late Spring and Summer Seasons. By Dayton Stoner. Roosevelt Wild Life Annals, Vol. 2, Nos. 3-4, January, 1932, pp. 267-764, col. pls. 1-2, figs. 117-234.

One is likely to expect this report to deal chiefly with local distribution, but, as a matter of fact, one finds that more attention is paid to the habits of the various species treated; and for this reason the paper will have a general appeal. Two colored plates are by Sawyer, whose skill in placing many small figures on one plate is well known.—T. C. S.

Birds Collected in Cuba and Haiti by the Parish-Smithsonian Expedition of 1930. By Alexander Wetmore. Proc. U. S. Nat. Mus., Vol. 81, Art. 2, pp. 1-40, pls. 1-7. Washington, 1932.

The expedition went by ship among various small islands adjacent to Cuba and Haiti, and the paper is a report on the birds collected, including land birds. An outline map of the territory covered would have been a great convenience to the reader.—T. C. S.

Progress Report of Ohio Upland Game Bird Research. By Lawrence E. Hicks. Reprinted from Trans. 18th Amer. Game Conf., 1931, pp. 1-5.

The matter presented here will be of interest to all who are engaged in game management.—T. C. S.

Bulletin of the Essex County Ornithological Club of Massachusetts. Salem, 1931. Pp. 1-71. Price, 50 cents (S. Gilbert Emilio, Treasurer, 7 Winter St., Salem, Mass.).

The principal paper in this issue of this Bulletin is a revised "List of the Birds of Essex County, Massachusetts", which includes 336 forms, with a supplementary list of twenty-nine forms. This is a splendid way to publish local lists. A dozen other articles of interest are included.—T. C. S.

Research and Education in the National Parks. By Harold C. Bryant and Wallace W. Atwood, Jr. Issued by the National Park Service, Washington, D. C, 1932. Pp. i-vi+1-66.

A splendidly illustrated pamphlet describing the educational work attempted by the Government in the Parks, and giving a history of the development of this work. A useful bibliography is appended.—T. C. S.

A Revised List of the Birds of Ohio. Compiled by Milton B. Trautman. Bull. Bureau Sci. Research, Div. of Conservation, Ohio Dep't of Agric., Vol. I, No. 3, April, 1932, pp. 1-16.

A rather hastily edited, but modernized, list of birds for the state, which will be very useful to all Ohio bird students.—T .C. S.

Policies of the Bureau of Biological Survey Relative to the Control of Injurious Birds. Prepared under direction of Paul G. Redington and W. L. McAtee. Misc. Publ. No. 145, U. S Dept. Agric., Washington, D. C., 1932.

It is stated herein that the general policy of the Survey is "to hold bird-control work to a minimum". There follows a brief discussion of the various kinds of birds which may become injurious. The Biological Survey is often placed in a difficult position between conflicting demands. We hope that its practices will always tally with its declarations of policy.—T. C. S.

Quail Winter Food and Cover. By Paul L. Errington. Reprinted from Amer. Game, three numbers from July to December, 1931.

This reprint combines three instalments as originally published. It is a full official report of the Wisconsin Quail Investigation during the winter of 1930-31. Many interesting facts on the ecology of the Bob-white are here presented. The gist of it all is that these birds must have both food and shelter—the lack of either means disaster.—T. C. S.

Die Vögel Nordostgrönlands zwischen 73° 00′ und 75° 30′ N Br. By Bernt Løppenthin, of Copenhagen. C. A. Reitzel's Press, Copenhagen, 1932. Price, 6 Kroner.

During the summer of 1930 the Danish Godthaab Expedition spent six weeks on the east coast of Greenland. The author of this volume, who was Zoologist for the Expedition, devoted most of his time to the birds, and obtained first-hand information on the birds between 73° 30′ and 74° 20′, North; but with information gained from the inhabitants he was able to report on the range indicated in the title. The volume contains a concise story of the movements of the Expedition a discussion of the forty species of birds found, and an adequate summary of both these parts in English. The text is supplemented with twenty-six text figures and one insert map.—Henry C. Rath.

Avifauna Aegyptiaca. Natatores, Steganopodes, Urinatores. By Alexander Koenig, of Bonn. Journ. f. Ornith., Special Number, 1932. Pp. 1-237.

The present one is the final instalment in a series, the first of which was completed in 1905. The title is slightly at fault, the author suggests, since, with two exceptions, the work deals only with the birds of the Nile Valley. The two exceptions refer to the birds of the Fayum Oasis and those of Sinai. Were it not for these exceptions a more appropriate title, he thinks, would have been, Avifauna Nilotica Aegyptiaca. Only genera and species are described. A total of

257 species, with many additional subspecies, are described in the work; while 38 species are discussed in the present instalment. Because human influence and natural events are producing rapid changes in the environment, the author reminds the reader that the picture which he here presents can be regarded only as a temporary one.—HENRY C. RATH.

EL TROUBADOUR. THE TEXAS MOCKINGBIRD. By R. A. Selle. Houston, Texas (1236 Rutland St.), 1932. Pp. 1-32.

Five delightful essays on the Mockingbird, all short, make this little booklet a prized possession. Anyone will enjoy this eulogy of the chosen bird of the state of Texas.—T. C. S.

FOODS OF SOME PREDATORY FUR-BEARING ANIMALS IN MICHIGAN. By Ned Dearborn. Bull. No. 1, School of Forestry and Conservation, Univ. Mich., Ann Arbor, Mich., 1932. Pp. 1-52, figs. 8, maps 10, charts 22. Price, 25 cents.

This paper, which deals with fur rather than feathers, is the first of a proposed series of bulletins to be issued by the Michigan School of Forestry and Conservation. Special attention has been given to the food of a selected list of mammals; and, of course, birds are found listed in these food charts in many cases.—T. C. S.

The *Migrant* for June contains an article by Mr. A. F. Ganier on the eagles found in Tennessee reprinted from the Journal of the Tennessee Academy of Sciences for April, 1931. Mr. Bruce P. Tyler also tells of a pair of House Wrens which destroyed two nests (with contents) of the Bewick's Wren and drove them away.

The *Chickadee*, organ of the Forbush Bird Club, of Worcester, Mass., continues to reach our desk regularly. It carries much information of general interest, and should be very suggestive to the editors of other local club publications.. The March number gives a list of trees, shrubs, and vines arranged according to the season (summer, autumn, winter, spring) in which their fruits are available as bird food. The July number gives a complete list of ornithological books in the local public library, with the call number for each one. This is a very fine list, but it should contain the *Condor* and WILSON BULLETIN. Other numbers are so full of facts and suggestions that enumeration would be quite impossible.

The St. Louis Bird Club issued two numbers (May and June) of a mimeographed periodical, the name of which was to be decided later. The pages serve to record the programs and field studies, and other matters of interest.

Bird banding periodicals. *Bird Banding Notes* is issued by the U. S. Bureau of Biological Survey. Since our last report the numbers for December ,1931, and May, 1932, have been issued. We have received *News from the Bird Banders* for October, 1931, January, April, and July, 1932; and also *Inland Bird Banding News* for March, June, and September, 1932.

The *Raven* has not missed an issue so far this year. This mimeographed Bulletin seems to restrict its space to actual news in the bird world as reported by the various active bird students in the state. The June issue presents an account of a three-day sojourn of a party of four in the Dismal Swamp.

The *Gull* for October reprints from the Game Breeder some interesting discussion on the question of how the Wood Duck's young leave the nest. The gist of it is that the young leave the nest, and are returned to the nest, on the back of the old bird. The author asserts that he has witnessed the performances.

The International Cat Society (501 Fifth Ave., N. Y.) issues from time to time a mimeographed bulletin which gives information on the harm done by these animals and on the work being done to curb the menace. Up to the present time ten bulletins have been issued.

Several numbers of the *Flicker* have arrived since last noticed. The second number for 1932 contains a halftone reproduction of a *very excellent* photograph of a Great Horned Owl at the nest.

For some years Prof. O. A. Stevens, of the North Dakota Agricultural College, has been issuing in mimeographed form *North Dakota Bird Notes*. This periodical has been issued with considerable regularity for a number of years, and contains a great amount of local ornithology.

It has been announced that the *Letter of Information* of the Nebraska Ornithologists' Union is to be discontinued at the end of this year, to be succeeded by a printed 16-page quarterly.

COMMUNICATIONS

Ridgway's Birds of North and Middle America

With regard to an editorial on Mr. Robert Ridgway's great series on the Birds of North and Middle America in the last number of the Wilson Bulletin (Vol. 44, September, 1932, p. 179) there seems to be some misunderstanding as to the circumstances attending the progress of this publication.

At the time of his death Mr. Ridgway was occupied mainly with work on the synonymy and on the diagnoses for the higher groups for volumes 9 and 10 of this work. Neither of these volumes was completed and we estimate that approximately 50 per cent or less of the work had been finished on them. Due to his failing health Mr. Ridgway did not feel that he could come to Washington to carry out the necessary work to complete the accounts of the various species and subspecies, and it was not practical for him to arrange to do this elsewhere. As a matter of fact Mr. Ridgway wished to give up the task some time before his death and continued only at my earnest solicitation, as it was my desire to have as much of his rich store of knowledge preserved on paper as possible.

The work of completion of these two volumes has been undertaken by Dr. Herbert Friedmann, U. S. National Museum, who follows Mr. Ridgway as curator of birds. While it is intended to complete the work as promptly as possible necessarily some time must elapse before the next volume is ready as there is much to be done upon it.

Alexander Wetmore,
U. S. National Museum, Washington, D. C.

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Dues for 1933

Annual Dues for 1933 Are Now Payable

This is the Treasurer's first notice to all members that dues for 1933 are now due and payable to the Treasurer

MR. W. M. ROSENE,
City State Bank,
Ogden, Iowa.

You are earnestly requested to remit at your earliest convenience, thus saving postage to the Club, and much time and effort to the Treasurer. A receipt will be returned only if requested.

Life Members	$100.00
Sustaining Members	5.00
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The Club values the continued support of every member, and every resignation is received with regret.

The reports of the officers for 1932 will be published in the March number. They will be of interest to those who wish to follow the affairs of the organization closely. In round numbers the income of the Club was $500 less than last year. We closed the present year (mid-November) with a bank balance of $547.52, about two hundred dollars less than it was a year ago. This safe balance was made possible by a reduction of expenses, chiefly in the size of the BULLETIN, and by the earnest efforts of the President and Secretary. We should endeavor to provide for such a balance, for it insures our solvency to the close of the calendar year and covers the cost of the current issue of the BULLETIN which is in press.

Our members can help the officers wonderfully this year by paying dues as promptly as possible, so that we may have an early knowledge of our resources and make plans accordingly.

In behalf of the officers of the Club the WILSON BULLETIN extends the greetings of the season to all of its readers, and wishes to thank them for their loyal and generous support.